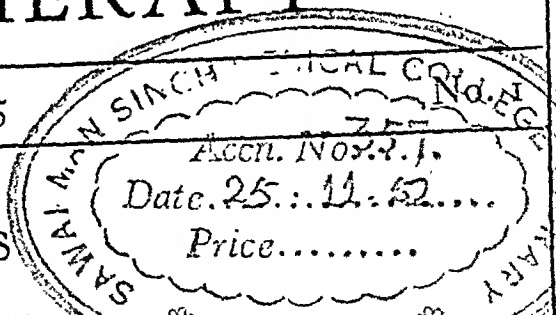




# THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. 53

JANUARY, 1945



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# THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Vol. 53

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No. 1

## ROENTGEN PATHOLOGY OF THE CHEST IN BATTLE CASUALTIES

By CAPTAIN DAVID S. CARROLL  
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and

CAPTAIN PASQUALE CIAGLIA  
*Medical Corps, Army of the United States*

A GREAT variety of pathological conditions of the chest has been encountered in battle casualties. The most frequent lesions we have seen have been rib fractures, metallic foreign bodies, blast injury with hemorrhage into lung parenchyma, pneumohemothorax, and atelectasis both postoperative and following pulmonary hemorrhage. Transdiaphragmatic and transmediastinal wounds have been frequent; and the multiplicity of lesions present in individual cases has repeatedly produced bizarre pathologic appearances. Because of the difficulty in examining a severely wounded soldier, and because of the complexity and multiplicity of the pathologic findings, the clinicians have depended largely upon the help of the roentgenologist, both in diagnosis and surgical judgment. A brief review of 8 selected cases follows.

CASE I. This patient, a soldier, aged nineteen, received a rifle wound of the left lower chest six days prior to admission to this hospital. The wound of entrance was 2 inches to the left of the midline at the level of the eleventh rib posteriorly. The wound of exit was in the left posterior axillary line over the ninth rib. The

symptomatology consisted of moderate dyspnea somewhat relieved by upright posture, and inability to take more than small amounts of liquid without vomiting. The physical findings consisted of hyperresonance to percussion, absent breath sounds in the lower two-thirds of the left chest, and a moderate displacement of the heart to the right. The general condition was good.

A single roentgenogram of the chest showed the gas-distended stomach in the left hemithorax reaching the level of the second interspace anteriorly. The left lung was markedly compressed and a slight amount of fluid was present above the stomach. There was a rather marked shift of the mediastinum to the right. The left eleventh and twelfth ribs were fractured posteriorly. Roentgenoscopy, after administration of barium by mouth, confirmed the diagnosis of herniation of the stomach through a rent in the left diaphragm (Fig. 1). The upper border of the stomach moved paradoxically with respiration. At operation, the spleen, not visible on the roentgenogram, was also found in the left chest.

CASE II. A soldier, aged thirty-seven, was wounded by shell fragments four days prior to admission. There were two wounds of entrance and two of exit over the right lower chest, one of them being about 2 inches above

the right costal arch in the mid-clavicular line with a tab of omentum protruding. The patient had moderate dyspnea and had a constant aching pain over the right lower chest, increased on respiration. Physical examination revealed



FIG. 1. Case I. Traumatic diaphragmatic hernia, with intrathoracic stomach.

flatness to percussion and absent breath sounds on the right. The abdomen was negative. A roentgenogram of the chest at that time showed a large amount of fluid within the right hemithorax compressing the right lung and displacing the mediastinum to the left. No subphrenic air could be demonstrated. Repeated thoracenteses were done and moderately bloody serofibrinous fluid was removed. On the third day of hospitalization the patient began to cough up bile which was confirmed by laboratory examination of the sputum; and a clinical diagnosis of biliary bronchial fistula was made. A chest roentgenogram at this time revealed only hydropneumothorax with multiple encapsulation. At operation there was a defect in the superior surface of the liver with a subphrenic pocket of bile walled off by the omentum. Above the diaphragm there was an encapsulated pocket of bile-stained fluid with the base of the lung adherent to the diaphragm. These two pockets of bile were communicating through a tear in the diaphragm.

*Comment.* This case is an example of extensive damage above the diaphragm

masking subphrenic pathology. The diagnosis of biliary bronchial fistula was made on clinical findings only, and no roentgen confirmation was attempted.

**CASE III.** The patient, aged twenty-eight, was admitted to this hospital with a diagnosis of superficial wounds of the left leg from fragments of a hand grenade incurred the day before, and a tentative diagnosis of possible appendicitis. On admission it was noted that he had a minute wound in the tenth interspace in the mid-axillary line on the left. Physical examination of the chest was negative and there was moderate generalized rigidity of the abdomen.

A roentgenogram of the chest in the upright position revealed air beneath the right diaphragm. The left diaphragm was indistinct but there was an irregular pocket of air at the left base (Fig. 2).

A perforated hollow viscus was suspected and a laparotomy was done. A moderate amount of blood was found in the abdomen, but no perforated viscus or bleeding point could be found.

The progress was uneventful until the fourth postoperative day when the patient developed

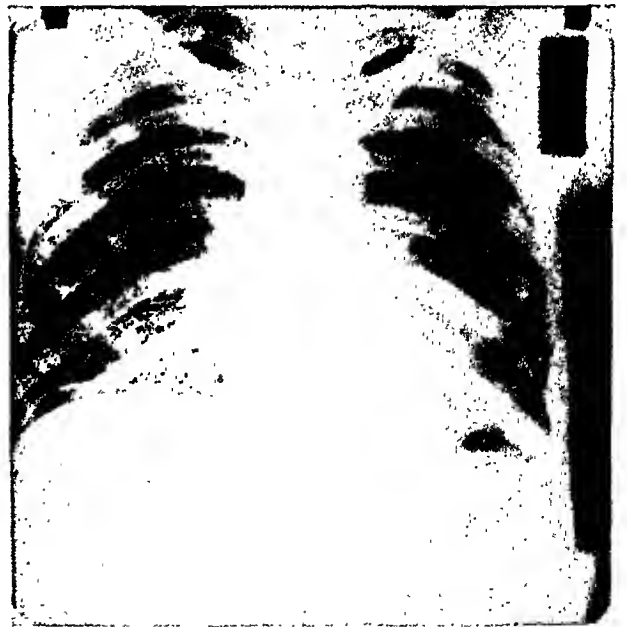


FIG. 2. Case III. Traumatic tear of left diaphragm; air beneath right diaphragm.

an atelectasis of the left lower lobe. At this time, in addition to an atelectasis of the left lower lobe, the chest roentgenogram showed a minimal left pneumothorax. Also two minute metallic foreign bodies could be seen in the left upper

quadrant of the abdomen, apparently in the spleen.

*Comment.* In retrospect it is believed that the metallic fragments traversed the base of the left lung and the left diaphragm, and lodged in the spleen. In the absence of perforated hollow viscus, the pneumoperitoneum was probably caused by the leakage of air from the left lung through the tear in the diaphragm. The hemoperitoneum was caused by small tears in the spleen. It is believed that an extensive pneumothorax did not develop because of pre-existing adhesions at the left base. This also accounts for the irregular pocket of air which was seen at the left base.

**CASE IV.** This patient, aged twenty-four, received a shrapnel wound of the left lateral chest four days prior to admission to this hospital. There was a small wound of entrance in the sixth interspace in the left mid-axillary line, and there was no wound of exit. The patient complained of some dyspnea, especially on exertion, and slight cough. He was afebrile and no precordial pain was present. A roentgenogram, taken elsewhere two days after the wound occurred, showed a normal cardiac outline and a moderate amount of fluid on the left. Although overpenetrated, this roentgenogram showed no evidence of foreign body. Physical findings indicated a left hydrothorax; the heart sounds were normal. A thoracentesis was performed and 900 cc. of bloody fluid removed. Four days later the dyspnea had increased and the patient had developed signs of fluid on the right. The heart sounds were somewhat muffled and a pericardial friction rub was elicited. A tap of the right chest yielded clear straw-colored fluid.

By that evening the patient had a moderate cardiac tamponade. A portable chest roentgenogram taken at  $\frac{3}{4}$  second exposure showed enlargement of the cardiac silhouette with sharply delineated borders. There was a minimal amount of fluid in the right main pleura and a moderate hydropneumothorax on the left. A pericardial tap yielded 150 cc. of bloody fluid with definite relief of the tamponade. Two days later 400 cc. of bloody fluid was removed from the pericardium. At that time a portable chest roentgenogram again showed the pericardial fluid, and pleural fluid bilaterally, more marked on the left. A faint shadow, suspicious

of a metallic foreign body, was seen in the lower left chest, and roentgenoscopy was advised. The electrocardiographic findings at this time were a prominent Q-I, elevated S-T-I segment, and cone shaped inverted T-I.

At roentgenoscopy there was little or no pulsation of the cardiac borders. A metallic foreign body, approximately 0.5 cm. in size, was seen well inside the pericardial shadow. This fragment exhibited characteristic ventricular pulsation and did not move with respiration (Fig. 3). Kymographic studies confirmed this motion.



FIG. 3. Case IV. Foreign body in heart, pericardial hemorrhage, bilateral pleural effusion.

It was thought that the fragment was in the myocardial wall and operation was therefore performed. At operation a small area of damaged myocardium covered by a friable blood clot was found in the left ventricular wall near the apex. The foreign body could not be located. However, at closure, a metallic strip was placed outside the pericardium on a level with the lower border of the heart to serve as a radiopaque marker. Subsequent roentgen examination showed the foreign body well above the marker in a position compatible with the cavity of the left ventricle.

*Comment.* This case shows the inadequacy of portable examinations with long

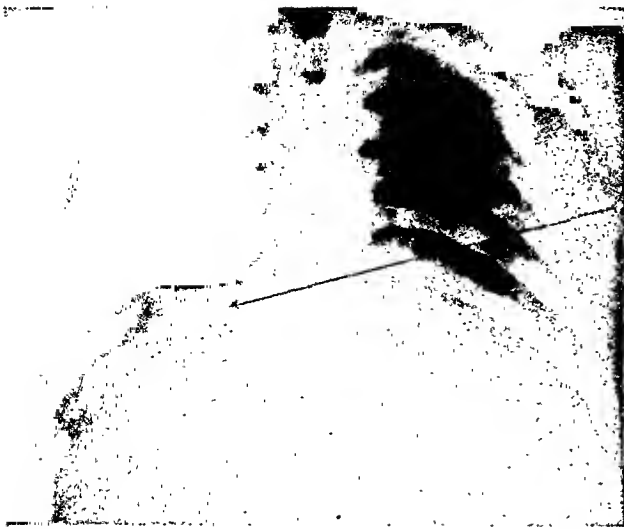


FIG. 4. Case v. Transmediastinal chest injury. Foreign body in right lung.

exposure technique. The foreign body would have been seen before if the roentgenograms had been taken with a shorter exposure time made possible by high milliamperage, using a kilovoltage sufficient to penetrate the shadow of the heart. Also the value of roentgenoscopy for foreign bodies of the chest is well illustrated. The diagnosis of pericardial effusion was made more difficult by the presence of pleural fluid bilaterally.

CASE V. The patient, aged twenty-nine, was admitted to this hospital two days after incurring a wound of the left chest caused by a shell fragment. On admission the physical examination revealed a wound of entrance in the left axilla at the level of the third interspace, but there was no wound of exit. Signs of fluid were present at both bases. The patient was moderately dyspneic on slight exertion.

Posteroanterior and lateral roentgenograms of the chest revealed subcutaneous emphysema of the left axilla. There was a moderate hydrothorax on the left. On the right side there was a more extensive hydrothorax and a minimal pneumothorax, which was encapsulated posteriorly. A large metallic foreign body, measuring 2.6 cm. in its greatest diameter, was present in the base of the right upper lobe anteriorly. There was some streaking of increased density which was interpreted as pulmonary hemorrhage surrounding the foreign body on the right and also in the left upper lung field (Fig. 4).

The foreign body was removed two weeks

after the injury. At surgery, the foreign body was surrounded by only minimal inflammatory changes.

*Comment.* The foreign body had entered in the left axilla, traversed the left lung and the anterior mediastinum, and had lodged in the anterior portion of the right upper lobe. This case emphasizes the fact that foreign bodies can travel quite a distance in the chest and traverse the mediastinum without injuring vital organs.

CASE VI. This patient, aged twenty-two, received a "sucking" wound of the posterior right lower chest due to shell fragment six days prior to transfer to this hospital. The only symptom on admission was slight dyspnea.

A chest roentgenogram revealed a moderate hydropneumothorax on the right. A foreign body, jagged in contour and measuring 2.3 cm. in its greatest diameter, was present in the right lower chest. It was lying just anterior to the eighth rib in the mid-scapular line. An azygos lobe was present. While the rest of the right lung was considerably retracted because of the hydropneumothorax, this azygos lobe had remained in place. However, the mesoazygos was concave laterally due to the altered intrathoracic pressure (Fig. 5).

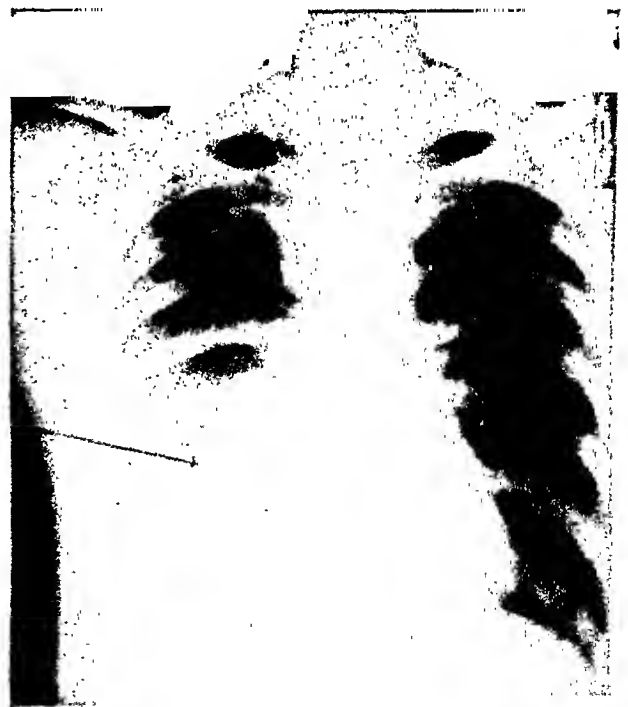


FIG. 5. Case vi. Foreign body in right lung with hydropneumothorax; azygos lobe.

The patient was treated by repeated aspirations. Subsequent roentgenograms taken ten days later showed no inflammatory reaction surrounding the foreign body, and the patient was still afebrile. There was still some residual hemopneumothorax, and this hemopneumothorax showed multiple encapsulation.

*Comment.* This case is one of the many cases of hydropneumothorax with foreign body recently seen. They have all shown early encapsulation of the fluid and air. This particular case was selected because of the unusual appearance of the azygos lobe.

CASE VII. This patient, aged twenty-one, received a bullet wound of the left knee four days prior to admission to this hospital. An open reduction was accomplished under pentothal anesthesia the following day. Two days prior to admission to this hospital, the patient noted the onset of a rather severe non-productive cough, and the gradual onset of substernal pain. This pain grew quite severe and was aggravated by coughing and deep inspiration. The pain spread toward the base of the neck. There was no fever, but moderate dyspnea was present. The entire respiratory episode lasted only about three days.

At the time of admission to this hospital the pain had almost disappeared and the only physical finding was a moderate subcutaneous emphysema at the base of the neck bilaterally.

A single chest roentgenogram revealed air in the supraclavicular soft tissues bilaterally and in the scaleni muscles to a lesser extent. No mediastinal emphysema could be detected and there was no pneumothorax. The heart and lungs were normal (Fig. 6).

*Comment.* The clinical picture is that of mediastinal emphysema with the gradual spread of the air to the base of the neck. Clinically and roentgenologically there was no evidence of pneumothorax, and the mechanism of the production of the mediastinal emphysema is probably that of rupture of alveoli bordering on a bronchus with air dissecting itself along the bronchus to the mediastinum and finally to the neck. Such mechanisms have been produced and described experimentally by Macklin, and clinically they have been described by

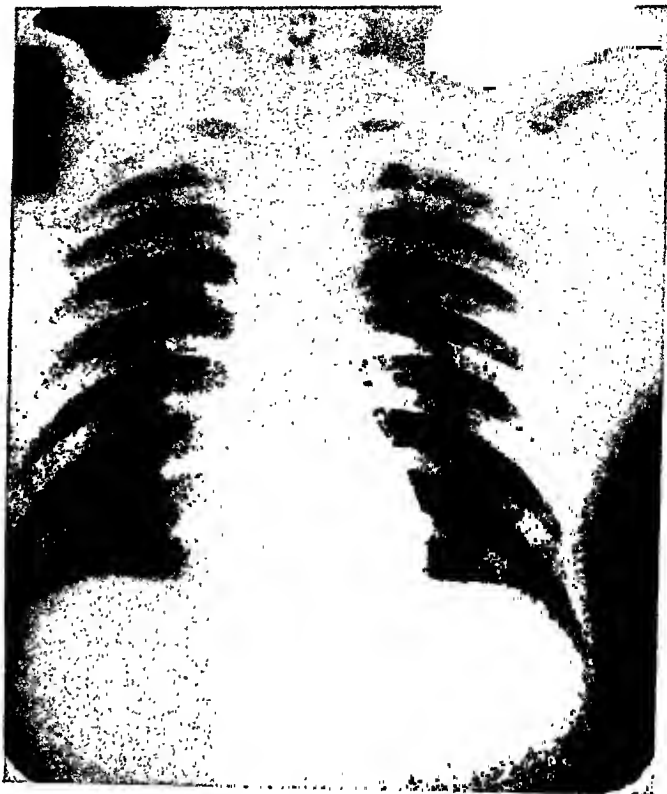


FIG. 6. Case VII. Supraclavicular subcutaneous emphysema following mediastinal emphysema.

others. Excessive cough, positive pressure anesthesia, and trauma have been the alleged causes. In this case it may have been the severe cough.

CASE VIII. The patient, aged twenty, was struck by a truck and brought immediately to this hospital. The diagnosis was simple fracture of the shaft of the right tibia and fibula. The fractures were immediately reduced and cast applied. Shortly afterwards he noticed a sudden onset of a constrictive pain across the mid-chest accompanied by considerable dyspnea and a dry hacking cough. By the next day the same symptoms had become severe and the sputum contained moderate amounts of bright red blood. Physical examination of the chest revealed a few scattered moist râles. Roentgen examination of the chest was negative. Numerous small petechiae were noted over the trunk and conjunctiva at this time. The respiration was very shallow and painful; and at one time the respiratory rate was as high as 50 per minute. The patient was semi-stuporous. The blood nonprotein nitrogen was 55, but the urinalysis was negative. The complete blood count was within normal limits and the blood cholesterol was normal. The temperature was never above 101° F. On the following day the



patient showed considerable clinical improvement.

On the third day roentgen examination of the chest revealed innumerable small discrete areas of increased density scattered evenly throughout both lung fields. These roentgen findings were compatible with a clinical diagnosis of fat embolism (Fig. 7).



FIG. 7. Case VIII. Pulmonary fat embolism.

Three days later the patient felt perfectly well, the petechiae had disappeared and another chest roentgenogram revealed that the areas of increased density had completely disappeared.

The final diagnosis was fat embolism. Apparently the changes seen in the lungs and skin disappeared with the passage of the fat through the pulmonary and cutaneous capillaries. This must have occurred while the pathologic changes described were still reversible.

#### SUMMARY

1. Eight cases have been selected from a large number of chest injuries recently seen. These have been presented to illustrate the variety and type of pathological conditions of the chest seen in battle casualties. Two cases, one of pulmonary fat embolism and one of mediastinal emphysema, were included although there were complications of injury elsewhere.

2. Because of the frequency of transdiaphragmatic wounds, it is preferable to examine the patient with a chest injury in upright position. If this is impossible the patient should be examined with a postero-anterior projection in the lateral recumbent position in order to detect subphrenic air.

3. Examinations of the chest using the portable unit and routine chest technique are often unsatisfactory because the foreign bodies are difficult to see beneath the diaphragm or behind the heart. For this reason we have often used overpenetrated roentgenograms. Roentgenoscopy has given valuable information in many instances.

4. The hemopneumothorax which accompanies chest injuries becomes encapsulated early due to the large amount of fibrin present. In several cases this encapsulation took place in the paramediastinal pleura and made the differential diagnosis between mediastinal pleural effusion and pericardial effusion difficult.

5. Although some of the foreign bodies have been large and carried in bits of clothing, and although some of the injuries have been severe, we have seen no roentgen evidence of infectious processes such as empyema, lung abscess, or mediastinitis. This is attributed to the early use of penicillin and chemotherapy.



# PNEUMOMEDIASTINUM IN THE NEWBORN\*

By ROBERT M. LOWMAN, M.D., and CHARLES S. CULOTTA, M.D.

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ALTHOUGH the previously reported cases of pneumomediastinum in the literature are relatively few, the experimental work of Fisher and Macklin,<sup>8</sup> together with the recent description of the condition in the adult, have tended to re-emphasize the syndrome. Guillot<sup>6</sup> in 1853 reported 2 cases of mediastinal emphysema in the newborn which were recognized at postmortem examination. Following Stran-sky's<sup>25</sup> review of the literature in 1928, Gumbiner and Cutler,<sup>5</sup> in addition to publishing observations on several cases of their own, were able to collect 8 cases from the previous reviews. Case reports by Schuler,<sup>21</sup> Kirchgessner,<sup>13</sup> Faber,<sup>3</sup> Poeck<sup>19</sup> and Rosen-blum<sup>20</sup> can also be found. More recent case studies by DeCosta<sup>2</sup> and Fisher,<sup>7</sup> were published in 1940 and in 1941. Smith and Bow-ser<sup>22</sup> reported 2 additional cases in 1942.

The series of cases reported by Hamman<sup>10</sup> in 1937 and 1939 did much to focus attention upon this condition and emphasize the associated clinical features. In the case report by Morey and Sosman<sup>18</sup>, the roentgen and clinical features of pneumomediastinum associated with a left spontaneous pneumothorax in an adult were presented. Graebner<sup>4</sup> reported 3 cases of pneumomediastinum associated with acute obstructive laryngitis. This observer contended that the occurrence of air in the mediastinum was directly influenced by the obstruction of the respiratory tract and was not due to the tracheotomy which was performed. Extrapulmonic air quickly disappeared after its continued extravasation was halted by eliminating the obstruction in the respiratory tract. In the series of cases of acute laryngeal obstruction presented by Michels,<sup>17</sup> pneumomediastinum associated with pneumothorax was reported following the tracheotomy. Cases of mediastinal emphysema and pneumothorax following

tracheotomy have also been reported by Forbes and Salmon.<sup>9</sup> Stenbuck<sup>23</sup> has also recorded 2 cases of primary mediastinal emphysema following severe crushing injuries of the entire chest.

The fact that pneumomediastinum is not more frequently mentioned does not mean that it is not recognized. The failure to record cases, however, gives the impression that the condition is rare. Speculation concerning the rôle played by pneumomediastinum in relationship to production of types of pneumothorax is interesting. Davis and Stevens<sup>1</sup> in 1930 reported an incidence of 6 cases of pneumothorax in the routine roentgenographic examination of 702 consecutive newborn infants. If pneumomediastinum precedes pneumothorax in such cases, an incidence of mediastinal emphysema of more than 1 per cent might be expected, since not all cases of air in the mediastinum will produce pneumothorax. In several cases reported by Hamman, pneumothorax probably produced by the escape of air from the mediastinum accompanied the interstitial and mediastinal emphysema. Graebner<sup>4</sup> reports a case in a six month old tuberculous infant in whom a pneumomediastinum developed. Following the increase in the amount of mediastinal air, a spontaneous pneumothorax was noted. The report by Fisher and Macklin<sup>8</sup> concerns a fatal result in a child of twenty months of age following aspiration of peanut kernels. Pulmonic perivascular emphysema of the left lung with the presence of large air bubbles in the anterior and superior mediastinum was found. Compression and obstruction by the emphysema of the pulmonary and mediastinal circulation resulting in severe dyspnea, cyanosis, anoxemia and impairment of the heart action produced death. It is important to stress Macklin's statement that although he was

\* From the Departments of Radiology and Pediatrics, Grace Hospital, New Haven, Connecticut.



able experimentally to force air from the mediastinum into the pleural spaces, no air could be introduced into the mediastinum from the pleural cavities. Nevertheless, the occurrence of pneumomediastinum following the initiation of an artificial pneumothorax has also been noted.<sup>16</sup>

In seeking the cause of the presence of any abnormal collection of air within the

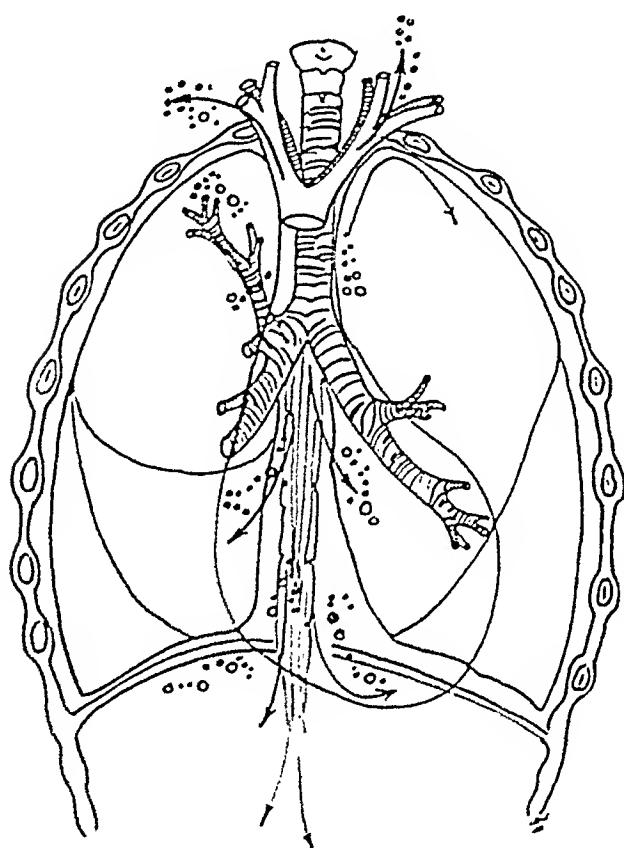


FIG. 1. Diagram demonstrating the direction of the spread of air. Pneumothorax results if rupture of the mediastinal pleura occurs. Pneumoperitoneum occurs following rupture of the peritoneum.

infant thorax, certain factors must be kept in mind. Among the variety of conditions apparently associated with mediastinal emphysema are those producing violent respiratory effects such as obstetrical labor, pertussis and obstructive tracheobronchitis. The factor of overdistention is important in those cases of intracranial hemorrhage, congenital heart disease, atelectasis with areas of compensatory emphysema where obstruction in the tracheobronchial tree is present. Macklin's work on experimental

animals has demonstrated conclusively that spontaneous pneumomediastinum results from pulmonary alveolar rupture. This investigator showed that artificial overdistention of a portion of the lung produced alveolar rupture with the passage of air along the vascular sheaths to the mediastinum. Any process tending to produce overdistention of the lung could also produce a pneumomediastinum. Weakening of the walls of the respiratory tract by a pathologic process so as to produce a break in the continuity of the walls may lead to the appearance of air outside of the normal pathways. Here such factors as congenital deformities of the respiratory system, local trauma or a pulmonary infectious process are to be considered. A definite predisposing factor would be the delicacy of the lung structure of the newborn infant, especially in the premature infant. Van Allen<sup>26</sup> and his associates have shown that the normally collapsed alveolar spaces may open under pressure to permit passage of air between adjacent alveoli, that similar spaces under pressure will permit air to escape into the surrounding connective tissues following the perivascular sheaths until the loose aerolar tissues of the mediastinum have been reached. Once mediastinal emphysema has occurred, numerous phenomena may follow (Fig. 1). Rupture of the mediastinal blebs into the pleural cavities may produce unilateral or bilateral pneumothorax. The extension of the compressed air along the great vessels into the cervical or the axillary areolar spaces or downwards into the retroperitoneal region may occur. Extension of the air along the blood vessels to the groins to produce subcutaneous emphysema in this region may also result. Pneumoperitoneum in such cases has been reported by DeCosta and Strongin. The experimental studies by DeCosta<sup>2</sup> demonstrated that increased pulmonic pressures as low as 18 to 20 millimeters of mercury were sufficient to produce a bullous mediastinal emphysema in dogs which later showed no evidence of lung damage. With application of increased pressures of 60 to 90 mm. of mer-

cury, the experimental animals often died suddenly of cardiac failure. Postmortem examination in such instances revealed in addition to the mediastinal emphysema, the presence of air emboli throughout the entire vascular system. Lindbloom has actually demonstrated air in the circulatory system of newborn infants who failed to respond to strenuously applied artificial respiration. In the cases where the air remains enclosed with the mediastinum under increased tension, various actions may occur. Because of the elastic and easily compressed walls, the pulmonary and systemic veins are first affected so that the return flow of blood to the right and left auricles is diminished. The resultant congestion in the peripheral veins in the lungs occurs early and causes dyspnea.

No symptoms are evident until the intramediastinal pressure reaches zero, but as soon as a positive pressure is noted rapid changes occur. Mediastinal emphysema occurring during the first few days of life is usually manifested by respiratory and circulatory distress. Rapid and shallow respirations are noted and, in association with this, dyspnea and cyanosis may be found. Bulging of the precordium, distention of the neck veins and a fall in the blood pressure are noted. These signs are dependent upon the blockage of the circulation brought about by compression of the systemic and pulmonary veins. Distention of the peripheral veins is most usually seen in the neck. Because of the downward and posterior displacement of the heart, its tones are distant and the percussion note over the heart is tympanitic. The air surrounding the heart may produce a peculiar crackling sound, synchronous with the systolic contraction. This latter finding in association with precordial pain has been an outstanding complaint in the adult cases. Complicating conditions such as pulmonary interstitial emphysema are difficult to diagnose clinically, and roentgenographic confirmation is necessary. In cases of mediastinal emphysema, pneumothorax may not necessarily be one of the associated findings.

Should pneumothorax be found, an alleviation of the symptoms may be noted probably due to the lowered tension in the mediastinum. Macklin has suggested artificial pneumothorax as a therapeutic procedure in mediastinal emphysema because collapse of the lung would tend to arrest the train of events increasing the collection of air in the mediastinum.

The diagnosis of pneumomediastinum is essentially a roentgen procedure although the condition may be suspected clinically. All cases of dyspnea and cyanosis in the newborn infant are routinely examined by means of frontal and lateral views as well as by means of roentgenoscopic examination. In the frontal view, air outlining the lateral margins of the superior mediastinum may occasionally be seen. Although some authors have stressed the lateral projection as offering the most conclusive evidence, it is seen that in several cases which are shown, air could be adequately visualized in the frontal views. In the lateral view, marked bulging of the precordium with the large area of encapsulated air immediately posterior to the shadow of the sternum is characteristic of pneumomediastinum. It is to be remembered that a marked pneumothorax may complicate a pneumomediastinum. With collapse of the elastic lung, much of the air in the mediastinum may thus be removed. For this reason, the roentgen studies in the frontal views may not be conclusive. Air in the pleural spaces may interfere and even obscure the mediastinal emphysema.

Jessup<sup>12</sup> considered the treatment of such cases from two aspects: control of the source of air and the production of an outlet to the air already accumulated. The treatment in all of our cases has been conservative, oxygen and stimulants being administered as was found necessary. Although the routine measures were employed in the first case, aspiration of the air was suggested by the consulting pediatrician. The child died before this procedure could be completed. The subsequent cases did not require therapeutic decompression. As-



FIG. 2. Case 1. Frontal examination of the chest made immediately following delivery shows no evidence of air in the pleural spaces.

piration of the mediastinum should be attempted only in the infants who fail to respond to the conservative measures described. While aspiration of air for the relief of massive mediastinal emphysema is definitely indicated and may be a life saving procedure, it may also fail to produce any favorable reaction because of pocketing of air in the loose connective tissues.<sup>9</sup>

With these features in mind, the cases of spontaneous pneumothorax in the newborn infant are reported.

**CASE 1.** Infant I., a girl, was born on November 17, 1940, weighing 4 pounds and 12 ounces. The child was delivered by caesarean section. Although the general condition was described as fair, the cry was feeble, associated with respiratory grunting and retraction of the lower part of the sternum. Artificial respiration was

administered by means of manual compression of the breathing bag followed by relaxation. Moderate cyanosis of the child was noted which continued although the patient was placed in an oxygen tent. Complete suppression of the breath sounds was present in the right chest. The heart sounds at this time were described as within normal limits.

Roentgenographic studies by Dr. W. G. H. Dobbs at this time demonstrated no evidence of air in the pleural spaces. In lateral views, obliteration of the anterosuperior mediastinum was suggested. It could not be determined whether enlargement of the thymus or the cardiac shadow was present (Fig. 2). Roentgen examination was repeated at 3:00 P.M. on October 18, 1940, and the features shown in Figure 3 were noted. A collection of air in the anterior mediastinum outlining an enlarged heart shadow and the thymus was noted. The thymus did



FIG. 3. Case 1. The re-examination in the frontal projection demonstrates a large collection of air in the anterior mediastinum outlining an enlarged heart shadow and the thymus. Bilateral pneumothorax is present.

not appear enlarged. A thin line of air overlying the margin of the right diaphragm can be seen. In the lateral view (Fig. 4), the thorax shows marked anterior bulging and immediately posterior to the sternum, a large collection of air can be seen. The lower esophagus is filled with air. Following ingestion of a small amount of barium, the lower esophagus and stomach were shown and found negative.

Following roentgen examination, the child became markedly cyanotic, and respirations stopped but the child was revived by means of artificial respiration. The child was seen by a pediatrician who suggested immediate mediastinal aspiration. Death occurred before this procedure could be completed.

An autopsy done immediately showed the marked bulging of the anterior chest which had been previously described. Both lungs were collapsed against the mediastinum which was present in the midline. No air could be found in the subcutaneous or the retroperitoneal tissues. No tears were visible in the mediastinal or the visceral pleura. The pleural domes were cautiously examined and no tears could be found in this region. The tracheobronchial tree was patent throughout. Microscopically, the lungs showed areas in which the alveolar outlines were not recognizable and there was considerable atelectasis. The myocardium was normal microscopically.

The marked mediastinal emphysema and bilateral tension pneumothorax which can be seen adequately in the accompanying roentgenograms produced marked respiratory and circulatory difficulties resulting in death. Previous observers have already noted that when pneumomediastinum is accompanied by a tension pneumothorax, the probability of a fatal outcome is definitely increased. It is unfortunate that mediastinal aspiration which was recommended by the pediatrician in charge was not completed.

**CASE II.** Infant C., a girl, was born on July 26, 1943, at 7:12 A.M., weighing 4 pounds and 13 ounces. The infant was delivered spontaneously of a thirty-year old white gravida III. The cry was spontaneous but weak, the color was poor and respiration was labored. Artificial respiration was attempted by means of 5 per cent carbon dioxide and 95 per cent oxygen. Tenacious mucus in the throat and nostrils was removed by intratracheal suction. Some improvement in respiration was noted. However,



FIG. 4. Case I. The lateral view demonstrates the marked anterior bulging of the sternum. The encapsulated air in the anterior mediastinum behind the posterior surface manubrium and the body of the sternum are shown. Because of the increased mediastinal pressure, the heart and superior mediastinal structures are displaced posteriorly. Air overlying the right diaphragm in the frontal and lateral views can be seen.

slight cyanosis was noted at this time. Physical examination showed marked suppression of the breath sounds on the left with obliteration of the cardiac dullness. No distention of the neck veins was seen. There was no bulging of the precordium and no subcutaneous emphysema could be palpated. The child was placed in a Hess oxygen bed, given stimulants, and immediate roentgenographic examination was made.

The examination in the frontal position (Fig. 5) showed depression of the domes of the diaphragms. No paravertebral translucent areas could be seen. There was no increase in the width of the cardiac silhouette. Although dimin-

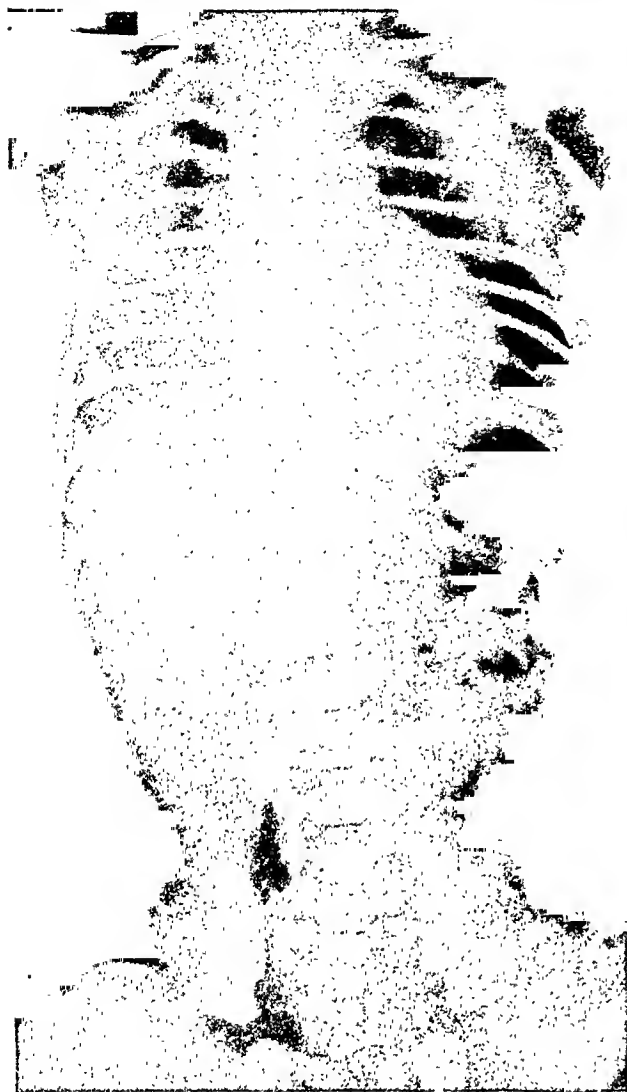


FIG. 5. Case II. No paravertebral translucent areas are seen. No increase in the width of the cardiac silhouette is shown. From this frontal view alone, a diagnosis of mediastinal emphysema cannot be made. (Contrast this projection with Fig. 3.)

ished aeration of the entire right lung was noted, emphysema of the left base could be seen. In the lateral view (Fig. 6), the sharply delineated translucent shadow of the encapsulated area in the anterior mediastinal region immediately posterior to the posterior margin of the manubrium and the body of the sternum could be seen with posterior displacement of the heart and mediastinal structures. With the diagnosis of pneumomediastinum thus established, the patient was returned to the oxygen tent. The child's respirations were noted as normal on the following day and no evidence of cyanosis was demonstrated. The air gradually disappeared from the anterior mediastinum over a period of three days and no recurrence

of the pneumomediastinum has been noted. Roentgen studies were made on July 28, 1943 (Fig. 7) and on July 29 (Fig. 8).

CASE III. Infant E., a boy, was born on August 10, 1943, at 3:21 P.M. The delivery was spontaneous of a twenty-seven year old white primipara. The general condition at birth was extremely poor, the color was moderately cyanotic and respirations labored. The child was given artificial respiration and 5 per cent carbon dioxide and 95 per cent oxygen inhalations. The examining pediatrician thought that a left-sided atelectasis with bronchopneumonia could account for the appearance of the infant. The roentgenographic examination on August 12,



FIG. 6. Case II. Lateral projection demonstrates the sharply delineated encapsulated air in the anterior mediastinum. No displacement of the mediastinal structures is shown. No bulging of the precordium is seen here as in the first case. The marked importance of a lateral view is demonstrated.

1943, showed no evidence of atelectasis or displacement of the cardiac structures. A diagnosis of pneumomediastinum was established. Again conservative treatment was resorted to and the child was kept in an oxygen tent continuously. On August 14, 1943, roentgenographic examination showed no evidence of air in the mediastinum. No recurrence of the cyanosis or respiratory difficulty was noted and the infant was discharged from the hospital on August 24, 1943.

Thus stressing the effects of increased intrapulmonic pressures, it is interesting to consider the rôle that artificial respiration might play in the formation of pneumomediastinum. Each of the infants in the reported cases received some form of artificial

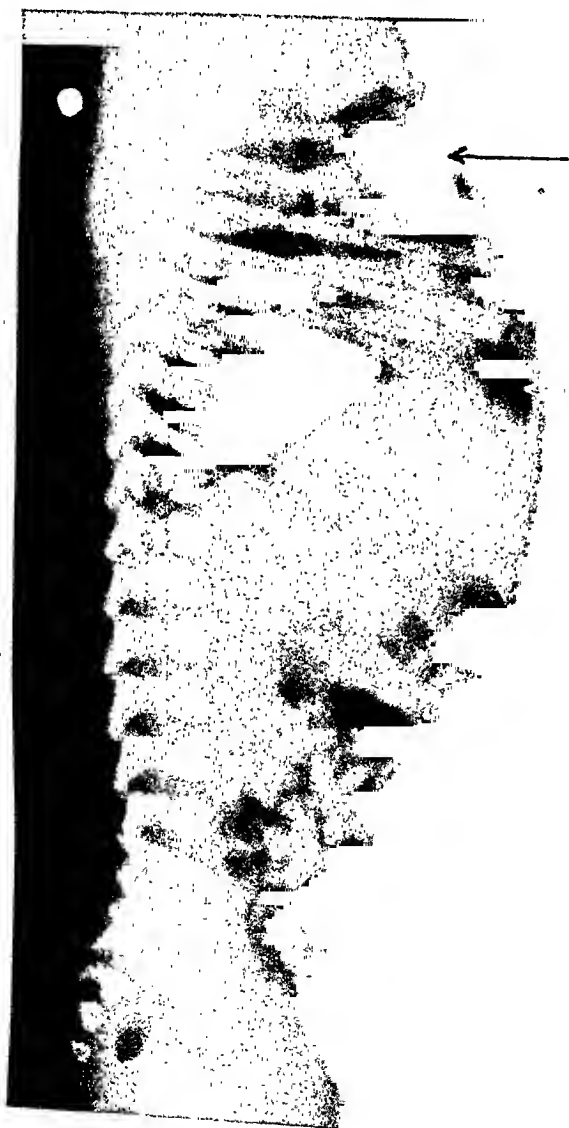


FIG. 7. Case II. Lateral projection thirty-six hours later showing a reduction in the amount of air in the anterior mediastinum.

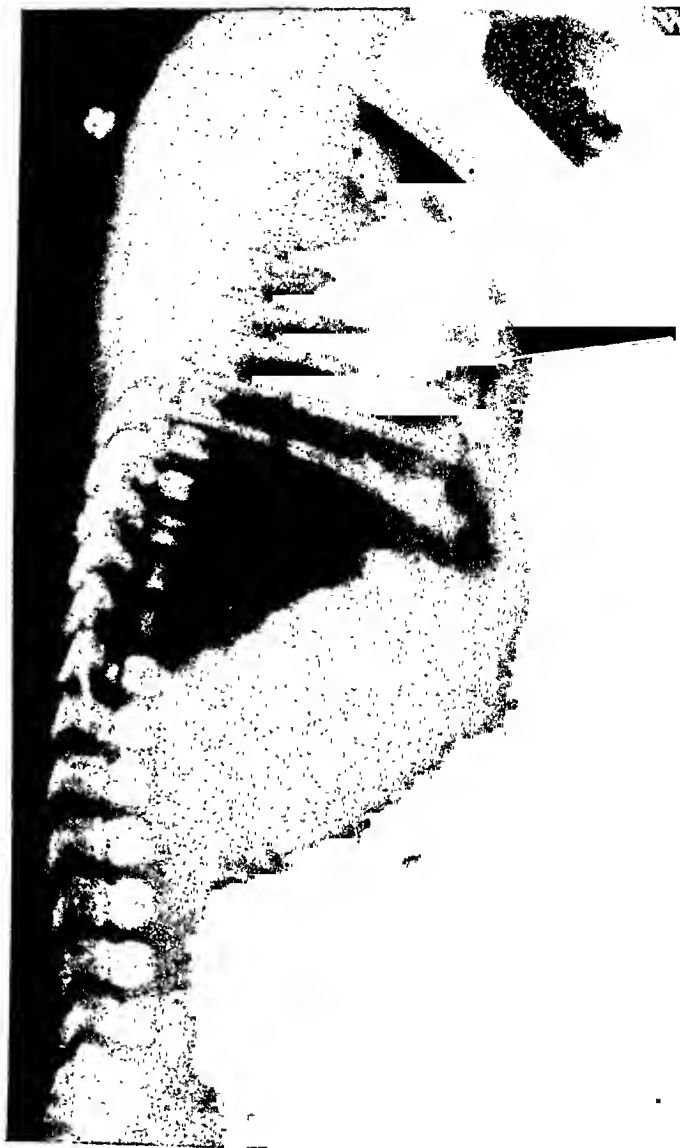


FIG. 8. Case II. Lateral projection demonstrating complete disappearance of the pneumomediastinum.

respiration. In Cases II and III, the manual compression of the breathing bag in the attempts to insufflate the lungs was described as being moderately vigorous. We have noted a case of pneumomediastinum and subcutaneous cervical emphysema in a seven year old boy following intratracheal catheterization and the application of artificial respiration. It must be remembered, however, that symptoms of respiratory difficulty were pronounced and that artificial respiration was resorted to in order to relieve the embarrassed breathing. It is difficult to determine in these cases whether the presence of the pneumomediastinum necessitated some form of artificial respiration or whether the attempted resuscitation

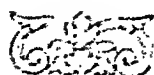


produced the air in the mediastinum. It is of significance that all of the cases received some form of artificial respiration and attempted insufflation of the lungs. That such methods are hazardous and should be administered by well trained individuals has been repeatedly stressed.\*

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\* See JESSUP, 1944, three additional cases of pneumomediastinum listed here.



# ECHINOCOCCUS CYST OF THE HEART\*

## REPORT OF A CASE

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### INTRODUCTION

ECHINOCOCCUS cyst of the heart is rare. Only 4 cases have been reported previously in American medical literature, 3 at autopsy and 1 in a living patient. Grulee<sup>7</sup> was the first to report a case of echinococcus cyst of the heart in 1905 in an Italian immigrant girl who coughed up cyst material and died suddenly five days later. Autopsy revealed a hydatid cyst the size of a pigeon's egg which had ruptured into the auricular chamber from the posterior wall. The lungs were full of small hydatid cysts. Davis and Balboni,<sup>3</sup> in 1917, reported the autopsy finding of echinococcus cyst of the heart associated with cysts of the brain and lumbar spinal cord. Mills,<sup>10</sup> in 1922, reported an autopsy on a thirty-six year old female in whom an echinococcus cyst 4 by 5 cm. in size was found at the apex of the right ventricle. He stated that no case of echinococcus cyst of the heart had ever been diagnosed in a living subject. In 1941, Atwood, Sargent and Taylor<sup>1</sup> reported an echinococcus cyst of the left ventricle in a living patient, an elderly white female, a native American residing in California. Both intradermal and complement fixation tests were negative.

As nearly as can be determined, 159 cases of echinococcus cyst of the heart have been reported to date in foreign literature. The first significant paper on the subject was by Griesinger<sup>6</sup> (1846) who reported 15 cases found at autopsy. In 1905 Grulee<sup>7</sup> collected 55 cases from the literature including those of Griesinger. These cases ranged in age

from seven to seventy-three years, 41 per cent being between fifteen and twenty-five years of age.

In 1928 D  v  <sup>4</sup> gathered and analyzed 137 authentic cases of echinococcus cyst of the heart. The heart was the only organ involved in 82 per cent of the cases and left-sided cysts were more common than right. Of 90 ruptured cardiac cysts, 20 ruptured into the pericardium, 38 into the right side of the heart and 32 into the left side. In D  v  's opinion, echinococcus cyst occurring in the heart is always primary. The last case reported in foreign literature was that of Fernandez Saralegui<sup>5</sup> of Argentina in 1941.

### CRITERIA FOR DIAGNOSIS IN THE ABSENCE OF AUTOPSY

The clinical diagnosis of echinococcus cyst of the heart is difficult because symptoms and signs are often absent, and if present, simulate other diseases. Echinococcus infestation usually occurs in childhood. The cyst may remain latent for many years. Symptoms and signs, when they arise, are usually due to three causes, namely: pressure of a growing cyst on the myocardium, or the acute allergic reaction to the escape of antigenic fluid from a ruptured cyst, or to the development of secondary cysts from metastasis of hydatid sand to adjacent or distant tissues and organs.

The roentgenologic observation of a rounded mass surrounded by a ring of calcification is of the greatest diagnostic importance. Blondau *et al.*<sup>2</sup> emphasize the heavy ring of calcification in the cardiac echinococcus cyst as almost pathognomonic

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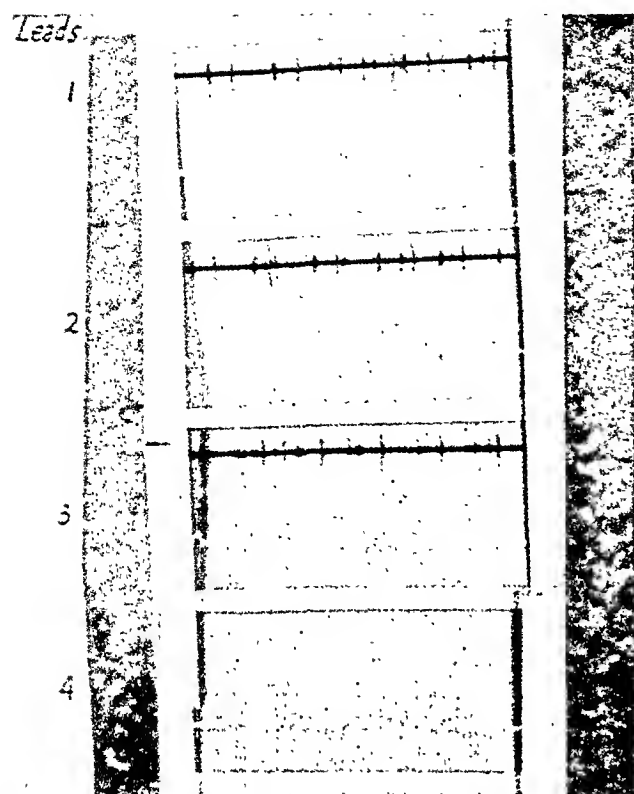


FIG. 1. Electrocardiogram and stethogram.

of cardiac rather than pulmonary cysts. The electrocardiographic findings are non-specific, being those of myocardial change or conduction defects.

Eosinophilia is present in 50 per cent of cases with active hydatid disease. The finding of hooklets, scolices or cyst fluid at operation, or during laboratory examination of the excreta or body fluids, is specific evidence of infestation by *Echinococcus granulosus*. Immunologic tests with *Echinococcus* antigen such as the intradermal, the precipitin and the complement fixation tests are positive in 87 per cent of cases with active disease. These tests are group specific, not species specific. Positive reactions have been obtained with antigen prepared from cestodes other than the *Echinococcus granulosus*.<sup>3</sup> The stools must therefore be examined carefully for the presence or absence of other types of cestode infestation, such as *Taenia solium* and *Taenia saginata*, before the true evaluation of a positive test with *Echinococcus* antigen is possible.

Immunologic tests may be negative if the echinococcus cyst either has been cured, or if its contents have become caseous and inert. In such a degenerative state, reagin may not be formed and immunologic tests may become negative.

#### CASE REPORT

The initial evidence leading to the discovery of a case of echinococcus cyst of the heart was found during the routine 35 mm. photofluorographic chest examination of recruits at the Sheepshead Bay Maritime Training Station, Brooklyn, New York. The 35 mm. film was reported as a cystic tumor in the heart or lungs. A confirmatory 14X17 inch posteroanterior roentgenogram revealed a rounded cystic tumor the size of a silver dollar with a ring of calcification at its periphery overlying the cardiac apex and adjacent lung. The patient was referred to the Station Hospital for further study.

C. T. R., a native American, white, male, aged twenty-eight, had considered himself in excellent health. He had always lived in the United States, from his sixth to ninth years in Florida, and the rest of his life in Connecticut. He is married, has one child, and for the past five years had worked as a bus driver. Since the age of ten, he has had "pet dogs." In his boyhood, his dog frequently shared his bed. He gives no history of urticaria, precordial pain, or cardiac decompensation, and has never had to limit his physical activities. His mother, aged fifty-seven, has been troubled with tapeworm disease for the last twelve years. She owns dogs, and the patient has been accustomed to petting and handling them.

Physical examination failed to reveal evidence of organic disease. The patient was a robust white male, weight 180 lb., height 5 feet 9 inches. The lungs were clear and the heart was normal. The apex beat was in the fifth interspace within the mid-clavicular line. The heart tones were of good quality. There were no murmurs or thrills. Heart and pulse rate were 72 per minute. The rhythm was regular and his blood pressure was 122/80. Abdominal examination failed to reveal enlargement of the liver, spleen, or kidneys.

**Laboratory Data.** The urine, sputum and feces examinations were negative. No evidence of tapeworm infestation was found.

Blood count revealed red blood cells to be 4,785,000. Hemoglobin was 16.2 gm. per 100 cc.; white blood cells were 8,200, with a differential of lymphocytes 34 per cent, polymorphonuclear leukocytes 66 per cent, and eosinophils 0.

The electrocardiogram revealed an inverted T<sub>1</sub>—coronary type, W-shaped Q-R-S<sub>1</sub>, splintered Q-R-S<sub>2</sub> and 3. This was interpreted as evidence of myocardial involvement (Fig. 1).

Intradermal test using 0.1 cc. of human echinococcus antigen obtained from the National Institute of Health at Bethesda, Maryland, was positive. An itching wheal appeared within five minutes after injection and reached a diameter of 2.5 cm. at the end of twenty minutes. Control inoculations with physiological saline were negative. Intradermal inoculations of the same echinococcus antigen in 10 normal individuals gave negative results. The echinococcus complement fixation test was negative. The precipitin test was not done. Blood Kahn and Wassermann tests were negative. Intradermal tuberculin test was negative.

Roentgenographic and roentgenoscopic examination of the chest revealed both lungs to be well aerated. The left diaphragm was tented by an adhesion in its midportion. The heart was in the midline. Its transverse diameter measured 16 cm. as compared to the internal



FIG. 3. Left lateral chest roentgenogram, 6 foot distance. Echinococcus cyst of heart.

transverse chest diameter of 35 cm. Bulging from the left ventricular wall 2 cm. above the cardiac apex on the posteroanterior view was a 4 by 5 cm. cystic tumor delimited at its periphery by a ring of calcification. It possessed a vigorous non-expansile beat synchronous with the cardiac pulsation and did not move with respiration. On the left lateral view the cyst overlay the left ventricle 2.5 cm. posterior to the location of the interventricular septum just inferior to the auriculoventricular groove. Posteroanterior, left and right anterior oblique views of the heart with barium in the esophagus, failed to reveal evidence of chamber enlargement (Fig. 2 and 3).

Roentgenographic examinations of skull, long bones, abdomen, and gastrointestinal tract were negative.

The clinical impression was echinococcus cyst of the left ventricle.

#### DIFFERENTIAL DIAGNOSIS

Echinococcus cyst of the heart must be differentiated from cardiac and pulmonary conditions such as gumma, aneurysm of the heart, rhabdomyoma, dermoid cyst, simple pericardial cyst, congenital lung cyst and tuberculous abscess of the lungs or heart with calcification. In all of these conditions



FIG. 2. Posteroanterior view, 6 foot chest roentgenogram. Echinococcus cyst of heart.

the echinococcus serological tests are negative and the characteristic ring-like calcification of the echinococcus cyst seen on roentgenographic examination is absent. Since the cyst in this patient moves only with the heart beat and not with respiration, its localization is definitely cardiac. Gumma of the heart is usually associated with positive serologic findings for syphilis and in view of the patient's age must be considered unlikely. In cardiac aneurysm there is usually a preceding history of coronary occlusion. The wall of the aneurysm pulsates abnormally and less vigorously than the normal cardiac tissues. Rhabdomyoma of the myocardium usually presents itself as a non-pulsating, non-translucent zone in the heart. A caseous, partly calcified tuberculous abscess may occur in the adjacent lung and become adherent to the heart. Its occurrence in the heart is extremely rare and is usually associated with acute hematogenous disease. The calcification, if present, is less regular than with echinococcus cyst. Congenital lung cysts adjacent to the heart move with respiration and rarely show calcification.

#### TREATMENT

There is no specific medical treatment for echinococcus cyst of the heart. Surgical removal has been successful. In 1932 Long<sup>8</sup> reported the first echinococcus cyst of the heart to be removed successfully. If the patient is asymptomatic, surgery may justifiably be postponed. The cyst frequently becomes regressive and the larvae die, resulting in a spontaneous cure.

#### PATHOGENESIS

Echinococcus disease is most common in sheep and cattle raising areas of Iceland, Australia, South America, South Africa, Asia and Europe, where its prevalence in man is directly proportional to its prevalence in sheep, cattle, pigs, and dogs. It is uncommon in the United States and Canada where, since 1880, a few more than 500 cases have been reported. Only 5 per cent

of these cases were in native born persons.<sup>9</sup>

The adult tapeworm, *Taenia echinococcus*, lives in the intestines of dogs and related animals. The ova which pass in the feces of the dog are ingested by sheep, cattle, horses or hogs which become the intermediate hosts for the larval or cystic stage of echinococcus granulosus. Man becomes an occasional intermediate host by the contamination of his hands, food, and drink with canine feces containing the ova. The echinococcus embryo is hatched from ingested ova in the duodenum of man. It penetrates the intestinal wall and travels by means of blood vessels and lymphatics to various parts of the body. Most commonly it enters the portal circulation and lodges in the liver where 76 per cent of all cysts are found. Less often it lodges in the lungs where 10 per cent of cysts are found. If it passes the hepatic and pulmonary capillary beds it may enter the coronary vessels and lodge in the myocardium. In the myocardium the embryo develops into an echinococcus larva. Within a few weeks the larva develops a protective cyst containing hydatid fluid. Growth of the cyst may continue for two to eight years. A single cyst may become as large as a child's head. A mature cyst has a double wall with an outer laminated membrane and an inner cellular layer enclosing cyst fluid which serves as a nutritive medium for developing scolices. Daughter and granddaughter cysts develop within the original cyst, and are common in man. Frequently after a period of growth the cyst becomes dormant or regressive, and undergoes heavy calcification. Its contents become inspissated and the larvae die. Early rupture of a cardiac cyst may occur because of the constant pull and tension of cardiac contractions. Scolices may then escape to adjacent tissues or into the blood stream resulting in cyst formation in distant organs. This condition is known as secondary echinococcosis. Symptoms of acute anaphylaxis, sometimes with fatal termination, may occur with rupture of the cyst. If leakage from the cyst is only

slight there may be few or no symptoms, and the break in the cyst wall may heal. However, rupture of the cyst may recur with more serious consequences.

## SUMMARY

1. A case of echinococcus cyst of the heart is presented.

2. The clinical diagnosis is based on characteristic roentgenoscopic and roentgenographic evidence of a calcified cyst in the heart wall along with electrocardiographic evidence of myocardial changes and a positive intradermal test with echinococcus antigen in the absence of other types of cestode infestation.

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# HYPERTROPHIC GASTRITIS SIMULATING INTRAMURAL TUMOR OF THE STOMACH\*

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**G**ASTRITIS manifests itself in many ways and may closely simulate other diseases.

The purpose of this report is to record and describe an interesting and instructive case in which localized gastritis simulated an intramural tumor of the cardiac end of the stomach.

## CASE REPORT

The patient was a soldier, white, aged thirty-two. He presented himself at a General Hospital on June 12, 1942 (overseas) with the following history:

*Chief Complaint.* Discomfort and pain in the epigastrium which was relieved by eating or alkaline powders since 1941.

*History of Illness.* Since 1941, the epigastric distress had been moderately severe, intermittent, but seemed to be increasing in severity for the past several weeks. During the past two days he vomited several times, and on at least one occasion the vomitus was thought to contain blood. He lost about 5 pounds in two weeks.

*Past History.* Essentially negative except for pneumonia in February, 1941.

*Family History.* Negative except for the fact that patient's mother died of intestinal obstruction. Mother and sister said to have asthma.

*Habits.* Patient has been a heavy beer drinker for the past ten or twelve years and habitually became intoxicated about three times a week. Usually smokes one and a half to two packs of cigarettes per day.

*Physical examination* revealed some pallor of the skin and mucous membranes, but was otherwise negative.

At the above hospital he was found to have blood in the gastric contents, positive stool guaiac tests, and achlorhydria. Roentgenoscopic and roentgenographic examinations on July 17, 1942, revealed what appeared to be multiple filling defects in the stomach, in the cardia, on the lesser curvature, and in the

prepyloric region. There was no stiffness or ulceration. The examiner suggested the presence of multiple polypi but mentioned the possibility of leiomyomata or fibromata.

*Laboratory Studies.* No free HCl was ever found. The total acidity ranged from 2 to 12 units on various occasions. Wassermann reaction was negative. Erythrocyte count, 4,896,000; leukocyte count 6,600, with 64 per cent polymorphonuclears and 36 per cent lymphocytes.

The patient was returned to the United States and was admitted to a General Hospital, on November 5, 1942. Study at this hospital corroborated the earlier findings.

A gastrointestinal series showed a definite tumor mass in the cardiac end of the stomach. Gastroscopic examination disclosed a large, thickened, irregular, ulcerated area on the greater curvature of the proximal stomach. This had the appearance of an infiltrative process.

On January 21, 1943, the upper abdomen was explored.

A large irregular flat tumor mass was found involving the posterior wall and extending on the lesser curvature side as far upward as the esophageal orifice, which appeared to be involved. High on the posterior aspect, the stomach was adherent to the posterior peritoneal wall along the spine. The entire mass was intramural. The serosa appeared normal. It was deemed inadvisable to attempt an abdominal resection because of the extent of the disease and the esophageal involvement.

The stomach was opened along the anterior surface and the stomach was explored by palpation to the esophageal opening in which several small nodules of tumor were felt. There was no ulceration. The mucosa appeared edematous, hypertrophic and posteriorly presented a raspberry-like appearance. A biopsy was taken from the mass in the posterior wall.

*Biopsy Report.* "Sections of mucosa and submucosa display slight irregularity of the mucosa and fibrosis of the submucosa. Dilated acini in mucosa and submucosa. Dilated veins in sub-

\* From the Department of Radiology, Walter Reed General Hospital, Washington, D. C.

mucosa. Scattered lymphocytes in mucosa and submucosa."

*Diagnosis.* Fibrosis; chronic inflammation.

A course of iodide therapy was given but the patient was not benefited. After a period of observation during which time the patient continued to have epigastric distress, and a few episodes of vomiting, he was sent to the Walter Reed Hospital for study and consideration of roentgen therapy.

Patient was admitted to Walter Reed General Hospital on April 15, 1943. At this time he appeared chronically ill and anemic. On April 16, 1943, examination of the gastrointestinal tract showed the presence of a lemon-sized circumscribed mass on the posterior wall of the cardia of the stomach very near the esophageal orifice. The gastric wall was stiff at the site of the tumor, and the cardia appeared to be fixed under the diaphragm. The remainder of the stomach was flexible and not definitely abnormal except for the presence of thick gastric rugae. The esophagus and duodenum appeared normal.

*Roentgenologist's Impression.* Benign intramural tumor (leiomyoma or neurofibroma).

*Gastroscopic Examination.* May 2, 1943. The stomach contained about 70 cc. of clear whitish fluid. Along the greater curvature and the posterior wall there was irregular thickening of the

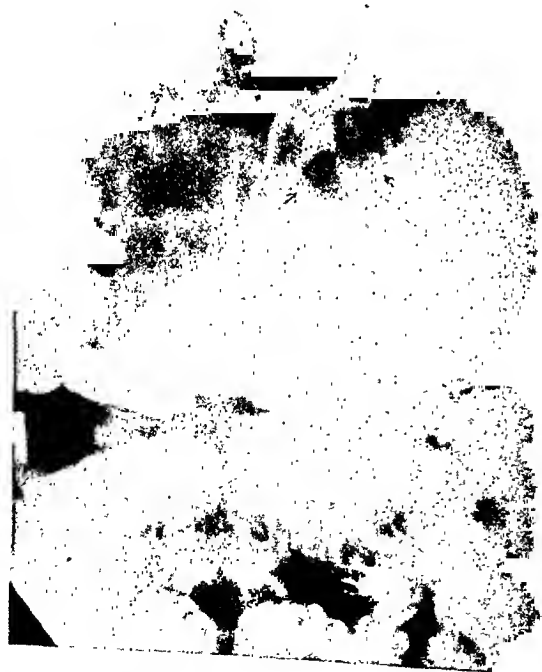


FIG. 1. Original appearance at overseas hospital on July 23, 1942. The filling defect in the cardia is well shown with the stomach completely filled.



FIG. 2. Trendelenburg position. Roentgenogram taken at Walter Reed General Hospital in April, 1943, using a few swallows of barium. The foot end of the table was elevated 45 degrees. The air bubble in the pars media shows heavy, somewhat ragged gastric rugae.

mucosa without ulceration or localized tumor mass. The esophageal-cardiac junction could not be adequately visualized.

*Impression.* "Diffuse benign gastric tumor, possibly leiomyoma."

The patient was presented at the tumor board where it was decided that he should be explored by the transthoracic approach in order to gain access to the cardia.

After a furlough the roentgen examination of the stomach was repeated in July, 1943. As no change in the appearance was found, the following operation was carried out:

On July 7, 1943, a left thoracotomy incision was made, the eighth rib resected, and the left pleural cavity was entered. An incision was made in the left leaf of the diaphragm from the esophageal hiatus laterally to the costal margin.

The stomach was found to be firmly adherent to all surrounding structures: posteriorly to the



FIG. 3. Mucosal relief study of cardia and fundus. Note the smoothly ovoid contour of the mass and absence of ulceration. April, 1943.

pancreas and peritoneum; superiorly to the diaphragm and right lobe of the liver; and inferiorly to the transverse colon and omentum. The stomach was bulky and its walls markedly

thickened, measuring 3 cm. in the fundus. In the cardiac portion, near but not involving the esophagus, there was a large oval mass about 8 by 4 by 5 cm. in size. This was palpated through the stomach wall. It was firm and was thought to be a tumor.

The adhesions binding the stomach were freed by sharp dissection. The spleen was rapidly removed in order to obtain a free approach to the greater curvature. The left gastroepiploic vessels were transfixed, ligated and cut. The left gastric artery was isolated, doubly ligated and divided. The esophagus was then cut across 1 cm. proximal to its entrance into the stomach. Two-thirds of the proximal portion of the stomach was then removed. The stomach stump was closed with continuous lock stitch for the mucosa and interrupted Lembert suture for the serosa. The stump of the stomach was closed in such a way as to make a tube, employing a portion of the lesser curvature. This portion of the stomach was then sutured to the under surface of the diaphragm without tension. An opening 2 cm. in length was made in the stomach and the open end of the esophagus was anastomosed to it. The anastomosis was performed by first suturing the serosa of the esophagus to the serosa of the stomach with



FIG. 4. *A* and *B*. Gastric pneumographic study. The patient drank sodium bicarbonate and water. The roentgenograms (anteroposterior and lateral) were taken with the patient standing erect. April, 1943. The tumor on the posteromedial wall of the cardia is projected into the gas bubble.



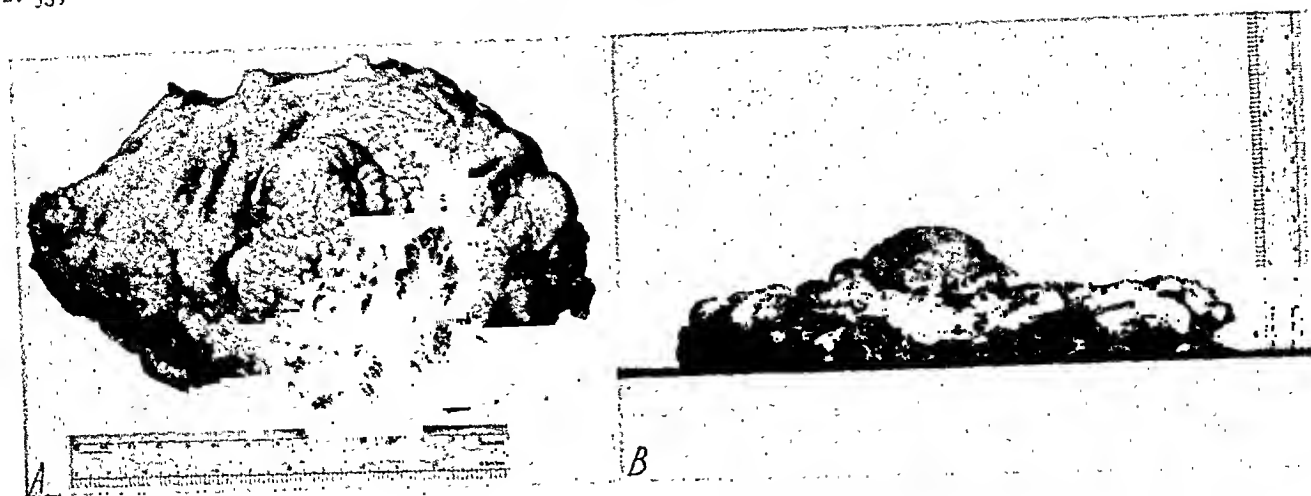


FIG. 5, *A* and *B*. Surgical specimen. Fresh gross appearance of resected stomach showing the closely packed and heaped up thick gastric rugae.

fine silk. The mucosa of the esophagus and the mucosa of the stomach were then sutured with interrupted fine silk. Anteriorly, the serosal layers were approximated with interrupted silk sutures. There was no tension on the suture line.

The opening in the diaphragm was closed with interrupted No. 2 mattress sutures, after placing 5 grams of sulfanilamide in the peritoneal cavity. Five grams of sulfanilamide were then placed in the pleural cavity and the thoracotomy wound closed, after the lung had been expanded.

*Examination of Specimen S-20433*—resected portion of the stomach and esophagus: weight, 360 grams. The serosal surface is smooth but shows some dense fibrous bands. The mucosal surface throughout is thrown into large irregular folds and there is an area just below the esophageal orifice measuring 6 by 4.5 cm. in which the mucosa projects as a large mass 3.5 to 4.0 cm. above the surrounding mucosa. There is no ulceration. The mass is situated posteriorly, and partially obstructs the esophageal opening. Sections through this area reveal diffuse thickening of the mucosa which varies from 0.5 to 1.5 cm. The muscular wall is sharply delineated and appears fibrous and edematous. This measures 1 to 2 cm. in thickness.

*Microscopic Examination.* Sections through the tumor mass and other portions of the stomach show diffuse hyperplasia of the mucosa which is entirely distinct from the underlying muscle. The gastric mucosa everywhere shows adenomatous hyperplasia of the mucous glands, associated with dense lymphoid and plasma cell infiltration. This infiltration extends down into the submucosa and muscularis and is accom-

panied in some areas by fibrosis. In some areas the glandular structures are markedly dilated, filled with mucus, and the epithelial lining is compressed and atrophic. There is no evidence of malignancy.

*Diagnosis.* Adenomatoid hyperplasia of the mucous glands with chronic, diffuse gastritis.

On the second postoperative day the temperature rose to 105° F., there was evidence of peritoneal irritation, fluid in the left chest and thoracentesis yielded blood-tinged fluid and some air. The abdomen became tender throughout, but not rigid, pulse and temperature continued to rise, and on the morning of July 12, 1943, the patient died. Autopsy was performed.

*Steenman Autopsy* (No. 3259 Reg. No. 193942). The left pleural cavity contained

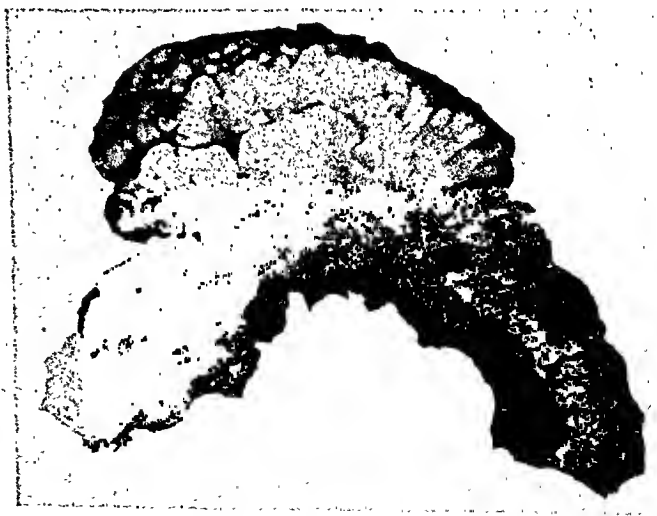


FIG. 6. Cut section of surgical specimen. All the coats of the stomach are greatly thickened, but the pseudotumor consists of only mucosa and submucosa. (Army Medical Museum negative No. 77893.)





FIG. 7. Surface epithelium. Photomicrograph ( $\times 230$ ) (Army Medical Museum negative No. 77898.) Surface epithelium underlying mucous glands resembling the glands normally found in the pyloric region.

1,500 cc. of thin brownish fluid which was foul smelling. The left lung was completely collapsed. The right lung showed congestion and edema. The collapsed left lung showed thick plastic exudate over the visceral pleural surface.

Dense adhesions were found between the remaining portions of the stomach and the left lobe of the liver and extending to the inferior surface of the left diaphragm.

The cardiac end of the stomach had been surgically removed. There was a reconstruction along the lesser and greater curvatures of the stomach forming a tube-like structure which was anastomosed to the esophagus. At the site of the anastomosis of the esophagus with the stomach, there was separation of the sutures, tearing of the esophageal wall and leakage of the gastric contents into the thoracic cavity. The wall of the esophagus was thin and friable.

The mucosa of the stomach showed congestion and in the antral portion several small adenomatous-like areas were found. There was no ulceration or other abnormality of the pylorus or the remainder of the gastrointestinal tract.

There was no generalized or localized peritonitis, and the remaining organs were not grossly or microscopically abnormal.

Cause of death: (1) pyothorax, acute, left, severe, secondary to break-down of esophago-gastric anastomosis; (2) collapse, left lung, secondary to (1); (3) adenomatoid hyperplasia of mucous gland of the stomach with chronic diffuse gastritis.

## DIFFERENTIAL DIAGNOSIS

A space-taking lesion in the cardiac portion of the stomach in a young man with achlorhydria, weight loss, and hemorrhage, necessitates consideration of the following in differential diagnosis:

### *Malignant Conditions:*

1. Carcinoma
2. Lymphoblastoma (particularly lymphosarcoma)
3. Malignant degeneration of polyp
4. Hemangio-endothelioma
5. Malignancies arising from benign tumors
  - (a) Leiomyosarcoma
  - (b) Fibrosarcoma
  - (c) Neurosarcoma (neuroblastoma)

### *Benign Conditions:*

1. Polyps (a) (simple polypoid)  
(b) (polyadénomes en nappe)
2. Leiomyoma
3. Fibroma
4. Fibromyoma
5. Neurofibroma
6. Aberrant pancreatic tissue
7. Lipoma
8. Angioma and "osteoma" (rare)
9. Some forms of hypertrophic gastritis

1. Malignant tumor was discarded as a possibility in this case because there was no demonstrable progression or metastasis of the tumor during the ten month period



FIG. 8. Submucosa. Photomicrograph ( $\times 145$ ) (Army Medical Museum negative No. 77897.) Dense lymphocytic infiltration and bizarre proliferating fibroblasts found throughout the submucosa.

of observation. Another important reason was the presence of an apparently intact mucosa overlying the mass. (In favor of malignancy, however, were the findings at the exploratory operation in January, 1943, the fixation of the cardia to the posterior peritoneal wall, and the small nodules found in the esophageal orifice.)

2. Benign polyps, fibroma, lipoma, and other tumors arising from the epithelial lining of the stomach were discarded because the lesion was not polypoid, discrete, pedunculated, or mobile.

3. Aberrant pancreas usually presents a more rounded defect with a central "dimple" at the duct orifice.<sup>13,16</sup> Also this is uncommon.

4. Extramucosal, intramural tumor of the stomach appeared to be the diagnosis of choice for several reasons:

(a) There was evidence of benignancy.

(b) The tumor was lemon sized, sharply outlined and protruded into the lumen from only one side, forming an obtuse angle with the stomach wall.

(c) It was sessile, and covered by what appeared to be intact, relatively smooth mucosa.

(d) The intact mucosa overlying the mass offered a possible explanation for the "tumor-negative" biopsy report in January, 1943.

(e) The lower esophagus and lower half of the stomach appeared relatively normal at roentgen examination and gastroscopy.

(f) While deep ulceration frequently occurs in intramural gastric tumors, the absence of ulceration is not significant.<sup>13,16</sup>

(g) The descriptions in the literature<sup>5,6,13,14,16,17,20</sup> appeared to be applicable in this case.

5. Localized hypertrophic gastritis with adenomatous characteristics was, unfortunately, not strongly considered because of the large size of the mass, the stiffness of the wall, the normal appearance of the stomach distal to the lesion and the strong prejudicial conviction that we were dealing with a tumor.

## DISCUSSION

Inflammatory diseases of the stomach have many times been mistaken for tumors. Attention was first called to the gross similarity of hypertrophic gastritis and carcinoma by Brunn and Pearl<sup>3</sup> in 1926. Since then, Schlindler,<sup>18</sup> Golden,<sup>9</sup> Buckstein,<sup>4</sup> and others, have contributed to the literature on the subject. In 1943 Freedman, Glenn and Laipply<sup>7</sup> reported 5 cases.

The diffuse types of gastritis ranging from the atrophic to the markedly hypertrophic and polypoid are seen frequently by the roentgenologist, but are best studied and classified by the gastroscopist. These are infrequently mistaken for tumors.

The gastritides encountered in the pars antrum and in the prepyloric region are more difficult to recognize and are still frequently misdiagnosed by the roentgenologist, the gastroscopist and even the surgeon who palpates the stomach at the operating table. The great frequency of gastritis in this portion of the stomach<sup>8</sup> prevents our overlooking this disease.

The localized gastritides, examples of which are shown by Buckstein,<sup>4</sup> Freedman, Glenn and Laipply,<sup>7</sup> and the case at hand are practically never diagnosed by any means before reaching the pathologist. This disease may occur in any portion of the stomach, but is slightly more common in the upper half and on the greater curvature.

In localized gastritis the mucosa is nearly always thickened to a variable degree. This may vary from 3 mm. to several centimeters. The height of the rugae is dependent upon the condition of the muscularis mucosae. The mucosal surface is usually coarsely granular and composed of closely packed mammillations. The mucous glands are tortuous, enlarged and deep. Frequently the glands are filled with secretions, producing minute cysts. The thickening of the mucosa may be uniform or irregular, in which case there is a definite polypoid character of the surface. Small or large superficial erosions of the mucosa account



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# MULTIPLE DIFFUSE PANCREATIC LITHIASIS

## ROENTGEN ANATOMY OF THE PANCREAS: CASE REPORT

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**P**UBLISHED cases of pancreatic lithiasis are not many, and a completely satisfactory picture of this entity and its complications has not yet been established. This case report is presented in particular from the following viewpoints: First, the multiple, diffuse nature of the calcifications offers an opportunity to study roentgenologically the anatomical relationships of the pancreas; second, abnormalities of small intestinal pattern related to the pancreatic disease are demonstrated roentgenologically; third, this case represents an early stage in pancreatic dysfunction as indicated by definite changes in the character and

content of the stool in the absence of any gross clinical manifestations of pancreatic insufficiency.

### CASE REPORT

The patient, aged thirty-five, gave a history of twelve acute attacks of severe upper abdominal pain during the past five years. The attacks usually started with pain in both hypochondriac regions, particularly on the right, with radiation to the back, under both shoulder blades, and to both costovertebral angles. The only noteworthy prodrome was constipation; there was no relation to fat ingestion or other diet. The attacks were accompanied by perspiration, relieved by morphine and generally subsided within a few days. There was no history of stone in the stool, jaundice, tetany or urticaria. In the intervals between attacks the patient was in good health. Childhood diseases included measles, chicken pox and mumps (no abdominal complications). Surgical history included a tonsillectomy at the age of six, hernioplasty at the age of eight, and an appendectomy at twenty-two. His teeth had been extracted seven years prior to admission.

The patient was first seen during an attack of severe abdominal pain as noted above. Tenderness was present beneath the right costal margin. The white blood count was 12,200, 69 per cent segmental forms, 19 per cent lymphocytes, 7 per cent stabs, 4 per cent eosinophiles, 1 per cent monocytes. The red blood cell count was 4.18 million. Clinically, the present attack was considered to be one of gallstone colic, as were his previous attacks. Under morphine treatment, the pain subsided considerably, although a slight residual pain persisted for several days.

Roentgen examination of the abdomen (Fig. 1) revealed numerous calcifications conforming to the anatomical location of the pancreas. A diagnosis of multiple, diffuse pancreatic lithiasis was made. Gallbladder study (Fig. 2), intravenous pyelography (Fig. 3), barium study of the large bowel (Fig. 4), and lipiodol study of the bronchial tree showed no roentgenologically

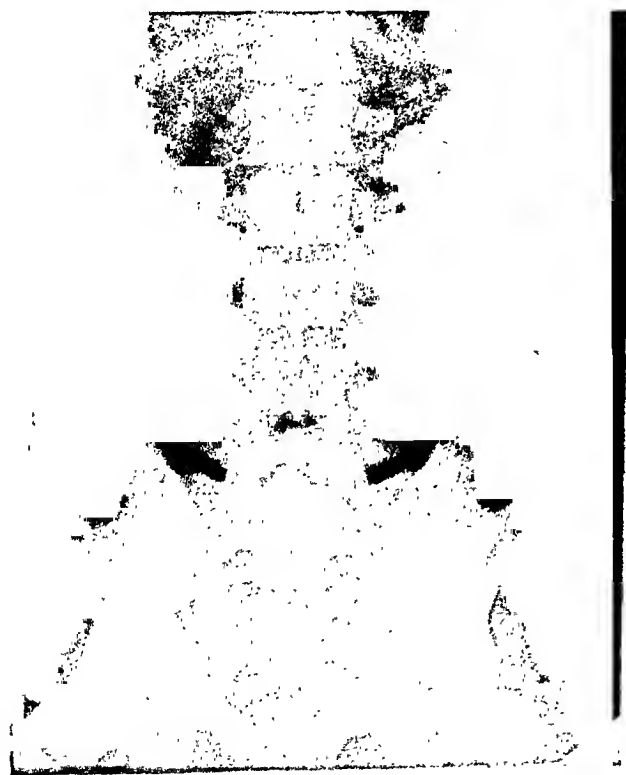


FIG. 1. This roentgenogram shows multiple, diffuse calcifications throughout the pancreas. Most of these are probably located in the main pancreatic duct and its branches. The head of the organ overlies the first and second lumbar vertebrae. The body and tail of the organ extend diagonally upward into the left upper quadrant.

demonstrable abnormalities of these organs. The calcifications were readily visualized on roentgenoscopy after thorough accommodation (some authors have failed to find them<sup>5</sup>). Roentgen studies of the small bowel (Fig. 5, 6, 7 and 8) showed abnormalities of the small bowel pattern including marked hypermotility, variation in motility, hypertonicity, coarsening



FIG. 2. This roentgenogram shows the gallbladder filled with dye. The calcifications in the head of the pancreas are seen to the left of this, over the first and second lumbar vertebrae. Although not found in this case, gallstones are frequently present in cases of pancreatic lithiasis.

and obliteration of mucosal folds and segmentation.

Repeated stool examinations were done over a period of several weeks. Bowel movements occurred regularly, twice daily. The stool was consistently well formed and very bulky, and the color varied between a clay color and light tan. Microscopic examination invariably showed a marked increase in muscle fiber content, and very many fat globules and fat crystals. Sudan stain was used to further demon-

FIG. 4. Barium enema shows the head and body of the pancreas above the middle of the transverse colon. The tail is in direct contact with the splenic flexure.



FIG. 3. Intravenous pyelogram shows the relation of the head of the pancreas to the hilus of the right kidney. The body and tail extend across the upper pole of the left kidney to the hilus of the spleen.





FIG. 5. Barium meal study shows the head of the pancreas to be located within the duodenal loop. The body extends above the lesser curvature of the stomach. The duodenal loop is represented by a thin line of barium without any mucosal markings. Haziness and smoothness of outline of the upper jejunal loops are present.

strate the abnormal amount of fat globules. The increase in muscle fiber and fat content was present, even on a controlled low protein, low meat and low fat diet. Determination of total nitrogen excretion in the stool on the standard Schmidt diet revealed 4.995 grams of nitrogen to be excreted in a single day, much above the normal value.

Further laboratory examinations included two normal glucose tolerance tests; the serum amylase value was 93 units, the serum lipase value less than 0.05 unit, both within normal limits. The urinary amylase value was also normal. Serum calcium determinations were 9.2 mg. and 11.3 mg. per 100 cc. Total blood proteins were 6.2 grams per 100 cc.; albumin was 4.1, globulin was 2.1.

#### ROENTGEN ANATOMY OF THE PANCREAS

Although the calcifications in this case do not completely outline the pancreas, and associated pancreatic disease may have distorted somewhat the size and relation-

ships of the gland, the roentgen appearance conforms fairly closely with anatomical descriptions of the pancreas.<sup>4</sup> The head of the pancreas overlays the first and second lumbar vertebrae (Fig. 1); it fits into the concavity of the duodenal loop (Fig. 5, 6, 7 and 8). Defects of the barium-filled duodenum and pylorus due to carcinoma and other lesions of the head of the pancreas have been frequently described in the roentgenologic literature. From the head, the organ extends diagonally upward into the left upper quadrant. The body of the pancreas reaches above the lesser curvature of the stomach. This explains the roentgenologically demonstrable deformity of the lesser curvature of the stomach due to tumors of this portion of the pancreas. The tail of the pancreas crosses the upper part of the left kidney (Fig. 3) and extends to the hilus of the spleen. Here it is in direct relation with the splenic flexure of the colon, as well (Fig. 4).



FIG. 6. Small bowel study again shows the obliteration of the normal mucosal pattern of the duodenal loop. Exaggeration of the mucosal folds, hyper-tonicity, and irregularity of the pattern of the jejunum are noted.



In the dissection room the pancreas, a retroperitoneal organ, presents fairly constant relationships with the duodenum, kidneys, stomach, transverse colon and spleen. In the living, however, factors of habitus, assuming the erect posture, and respiration change its roentgen relationships, particularly with intraperitoneal organs of free mobility such as the stomach and transverse colon. Thus, in the erect posture the stomach and transverse colon fall considerably below the body of the pancreas. Factors of projection must also be considered.

#### ABNORMALITIES OF SMALL INTESTINAL PATTERN

Abnormalities of small intestinal pattern and motility have been demonstrated roentgenologically in sprue, celiac disease, and vitamin deficiency states,<sup>3</sup> with drugs,<sup>2,6,11</sup> inflammatory diseases of the small intestine,<sup>11</sup> liver disease, allergy,<sup>11</sup>



Fig. 7. Small bowel study shows considerable thickening and irregularity of the mucosal pattern of the duodenum and jejunum. Segmentation is present.



Fig. 8. This roentgenogram demonstrates marked hypermotility of the small bowel. Barium is present in the hepatic flexure fifteen minutes after ingestion. Considerable variation of small bowel motility is noted by comparison with Figure 7 in which barium has only reached the ileum at the end of one hour.

emotional states, and with variation in the bowel content,<sup>9</sup> as well as in other conditions. Motor intestinal disturbances including gastropasm and pylorospasm have been noted in pancreatic lithiasis.<sup>10</sup> This case demonstrates several noteworthy changes in the small bowel including segmentation, obliteration of mucosal pattern, exaggeration, irregularity and coarsening of the mucosal folds, and hypertonicity. Figure 8 shows the presence of barium in the ascending colon at the end of fifteen minutes after ingestion, indicating marked hypermotility. Variation in motility is demonstrated by comparing this with Figure 7 in which the barium has only advanced to the ileum at the end of one hour. There was no gastropasm or pylorospasm.

The mechanism of production of the abnormal small bowel pattern in this case may be related to a vitamin, protein, or other



deficiency state<sup>3,11</sup> due to the pancreatic disease. A nerve reflex or chemical effect<sup>2,6</sup> from the diseased pancreas may be implicated, especially with regard to the changes in motility. The effect of a large amount of undigested fat on intestinal pattern has been shown.<sup>9</sup> A further interesting consideration in this case is the possible effect of the abnormal amount of muscle fiber and increased protein on the intestinal pattern.<sup>9</sup> This lack of digestion of muscle fiber, and increased protein excretion are even more diagnostic of pancreatic insufficiency than is the lack of proper fat digestion.

#### PANCREATIC INSUFFICIENCY

Although pancreatic lithiasis is roentgenologically a distinct entity, its clinical significance in great measure depends on the associated pancreatic disease and insufficiency. Etiologically, it is related to pancreatic necrosis.<sup>7</sup> Stones have been found in association with hemochromatosis,<sup>10</sup> and with carcinoma of the pancreas.<sup>10</sup> Changes in the pancreas secondary to the presence of stones include atrophy, fibrosis, and cystic changes;<sup>7</sup> the islands of Langerhans may be affected, although usually late in the process. Secondary fatty changes may occur in the liver.<sup>10</sup>

Marked weight loss, wasting and cachexia occur in lithiasis with advanced pancreatic insufficiency due to the impaired digestion of fats and proteins, and associated vitamin and other nutritional deficiencies.<sup>10</sup> Frank diabetes may result from atrophy of the islands of Langerhans.<sup>10</sup> Liver metabolism is also affected.<sup>10</sup> Tuberculosis<sup>10</sup> and other pulmonary complications<sup>7</sup> not infrequently supervene. Lipiodol study of the bronchial tree is indicated, particularly in view of the pulmonary changes that have been so frequently found in cystic fibrosis of the pancreas in infancy.<sup>2</sup>

This patient did not manifest any gross clinical evidence of pancreatic insufficiency. There was no wasting, cachexia, diabetes, or evidence of secondary changes in the

liver, lungs, or other organs. A diagnosis of early pancreatic insufficiency is justifiably made, however, on the basis of the markedly increased excretion of fat and protein in the stools, with characteristic color and bulk.<sup>8</sup> Substitution therapy with pancreatic enzymes, and a controlled high calory, high vitamin diet may prevent some of the serious results of pancreatic insufficiency noted above.<sup>1</sup>

#### SUMMARY

A case of multiple, diffuse pancreatic lithiasis representing an early stage of pancreatic insufficiency is reported. Changes in the small intestinal pattern are demonstrated roentgenologically. The roentgen anatomy of the pancreas is discussed.

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# MULTIPLE PLASMOCYTOMA OF THE JEJUNUM\*

## REPORT OF A CASE

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THE plasmocytoma, a tumor composed almost exclusively of plasma cells, may occur in nearly any part of the body. By far the most frequent site is the bone marrow, constituting the plasma cell myeloma, either solitary or multiple. Less commonly, these tumors occur outside the bone marrow. Hellwig<sup>3</sup> recently reviewed 128 cases (127 published cases and 1 of his own) of "extramedullary plasma cell tumors." Most of these occurred in the respiratory passages (64 cases) and in the conjunctiva (47 cases). Only 5 cases are reported in which the tumor involved the small intestine. In 1924, North<sup>5</sup> reported the case of a forty-seven year old woman who suffered abdominal discomfort and progressive weakness for three months. A laparotomy, performed to relieve an intestinal obstruction, revealed tumor involving two segments of about 35 cm. of ileum. On microscopic examination, the tumor was found to be infiltrating all intestinal layers and composed of plasma cells with numerous mitoses and little intercellular substance. The mesenteric lymph nodes were not examined. Vasiliu and Popa,<sup>9</sup> in 1928, reported the autopsy findings in a woman, aged thirty-two. They described ulcerating nodular tumors in the mucosa of the stomach, ileum, and sigmoid colon. There were clumps of mesenteric lymph nodes compressing the ileum. All these areas showed masses of plasma cells. Razzaboni<sup>6</sup> reported a case showing ulcerated tumors in the terminal ileum, cecum, and appendix. These tumors were composed exclusively of plasma cells. In 1930, Vallone<sup>8</sup> reported the case of a twenty-four year old man who presented a history of recurrent attacks of severe right lower abdominal pain suggestive of chronic intestinal obstruction. A

first laparotomy was limited to draining a local peritonitis. At a second operation, a tumor obliterating the lumen of the ileum was found. The tumor was composed of plasma cells and some lymphocytes. It had invaded the submucosa and muscularis. Brown and Liber<sup>1</sup> described the case of a Negro, aged fifty-seven, who had had a purulent rectal discharge for ten to fourteen years. There was a twenty year history of lues. Numerous polypoid masses encircling the rectum were noted. At autopsy, following death from pneumonia, there were found numerous masses of firm, yellowish-white tissue elevated above the serosa and distributed throughout the entire ileum. At the hepatic flexure of the colon there was a localized chronic perforating abscess associated with a polypoid mass and infiltration of the walls of the colon. The perirectal tissues showed the same infiltration. These intestinal masses and the regional lymph nodes were composed of "solid sheets of plasma cells (about 80%)" and lymphocytes with varying degrees of fibroblastic induration. Amitotic division of plasma cells was observed. These plasma cell collections infiltrated all the intestinal coats and the epiploon. There was invasion of the blood vessels by similar cell masses. These authors state that the findings did not resemble regional ileitis granuloma or granuloma venereum. Recently we have had occasion to observe the roentgenograms of a case seen at another hospital by Dr. C. L. Hinkel.<sup>4</sup> These showed multiple constrictions in the small intestine with destruction of the mucous membrane. A biopsy from one of the mesenteric lymph nodes was taken. The histopathological picture was interpreted by one of us (A.P.S.) as plasmocytoma.

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Swenson,<sup>7</sup> in a recent review of small intestinal tumors, included the following case. However, the condition is of such rarity it seems advisable to report it in further detail under the above title.

#### CASE REPORT

R. S. (610245), a Costa Rican merchant, age thirty-five, was first seen by Dr. C. Flood on May 9, 1940. He presented a history of three episodes of gastrointestinal hemorrhage in the preceding three years. In 1935 the patient was discovered to have syphilis. After two years of intensive treatment, his blood Wassermann

bowel habit was experienced. Although anorexia was a prominent symptom, the patient had not lost weight. There was never any jaundice or fever.

*Past History.* As a youth he had malaria. Following an attack of "flu," he had rheumatism but the joints were not swollen nor red. The illness was of short duration. In his early youth he contracted a neisserian infection for which he received treatment for eight months. There have been no recent symptoms referable to this. Except for a myringotomy and nasal operation in 1922 he had never undergone surgery. A review of the systems was otherwise non-contributory.



FIG. 1. Pressure roentgenograms of the narrowed area in the jejunum showing destruction of the mucosal folds. The circle on the left shows an irregularity on one side of the constriction suggesting an ulcer.

became negative and he was discharged as cured. In 1937 he experienced a rather severe intestinal hemorrhage for which he received two transfusions and was later treated with iron. One year following this episode, a similar hemorrhage occurred. At this time, his blood Wassermann again became positive and treatment was re-instituted. One week after a third neo-salvarsan injection, another hemorrhage occurred. With this episode of melena, the patient vomited but the vomitus did not contain blood. Examination of the stool at that time did not reveal any ova or parasites. Since the last hemorrhage which occurred two years prior to his first visit, the patient had suffered a dull, steady pain in the left upper and lower abdomen. This was unrelated to meals and was only partially relieved by alkali. Nausea was quite frequent, and the patient resorted to induced vomiting for relief. No difficulty at all with in-

*Physical examination* revealed a rather pale depressed man, looking chronically ill. No jaundice, cyanosis or dyspnea was observed. Eyes: dilated pupils which reacted well to light and accommodation. Throat: negative. There were no palpable lymph nodes. Heart and lungs: negative. Abdomen: no palpable masses or localized tenderness. There was no abdominal distention. The liver, spleen, and kidneys were not palpable. Rectal examination, including proctoscopy, disclosed a few small hemorrhoids and dilated crypts. No rectal masses were present. Mild varicocities were noted in the left leg.

*Laboratory Findings.* Hemoglobin, 13.5 gm.; 1st post-erotic erythrocyte count, 5,140,000; 2d leukocyte count, 17,200, with polymorphonuclear leukocytes 66 per cent (11,400), lymphocytes 22 per cent (2,900), monocytes 9 per cent (1,200), eosinophils 2 per cent (280). The blood smear showed

slight anisocytosis. No parasites were seen. Platelets appeared normal. Kline test, negative. Urinalysis, negative.

A gastrointestinal series was done on May 10, 1940. A narrow constriction which had slightly irregular walls was noted in a loop of lower jejunum. Pressure roentgenograms made of this area (Fig. 1) showed an apparent absence of the mucosal folds over a short distance. The constriction appeared to be 3 cm. in length and varied in width from time to time. An irregularity was noted on one side of it which suggested an ulcer (Fig. 1). Other loops in this immediate neighborhood appeared quite narrow but it was impossible to be certain about loss of mucosal folds except in this one area. Under the stimulus of pressure these loops emptied rapidly. The patient localized his pain in this area in the left iliac fossa. Distal to this the ileum and cecum showed nothing remarkable. The esophagus and stomach appeared normal although the stomach was quite hypertonic and sluggish with a spastic antrum.

The patient was admitted to the Presbyterian Hospital one week later. Preoperative decompression of the intestine was attempted with the Miller-Abbott tube. However, the tip of the tube was arrested for thirty-six hours at the ligament of Treitz. The surgeon later noted the presence of organic obstruction just distal to this area which accounted for the arrest. On May 20, 1940, a laparotomy was done by Dr. Louis Rousselot. Beginning immediately at the ligament of Treitz and continuing at almost equally distant intervals of between 6 and 8 inches along the course of the jejunum, there was a series of six identical, annular, soft constrictions of the bowel of approximately 2.5 to 3 cm. in length with intervening normal appearing intestine for a distance of about 14 to 16 cm. The serosa overlying the lesions was a dull grayish-white color. The intestine was puckered around its circumference. The process apparently extended several millimeters into the mesenteric attachment. Careful examination of the mesentery revealed no grossly abnormal lymph nodes. The stomach, duodenum, terminal ileum, colon and liver were all explored and were grossly normal. A biopsy was taken at the site of the third lesion and examined by frozen section. Upon finding evidence of malignant tumor, the jejunum with attached mesentery at this site was resected and an end-to-end anastomosis effected. Gross and



FIG. 2. Roentgenogram taken fifteen minutes after the ingestion of barium and showing a narrowed area about 3 cm. in length in the proximal jejunum. Dilatation of the jejunum proximal to the constriction is demonstrated.

histological examination of the specimen is discussed below.

On the second postoperative day, the patient passed both dark and bright red blood by rectum. Except for this episode, the postoperative course was uneventful. There was a temporary secondary anemia without evidence of abnormal white blood cells. The urine was negative for Bence-Jones protein. As a therapeutic trial, radiotherapy was instituted. He received 1,860 r (measured in air), with 200 kv., half-value layer 1.8 mm. Cu, to an anterior abdominal field 20 by 20 cm. This course of treatment extended over a period of two months. It was then discontinued because of recurrent nausea and a tendency to leukopenia. On July 26, 1940, about two months after operation because of a persistent secondary anemia attributed to the irradiation, a transfusion of 500 cc. of whole blood was given. At this time, the leukocyte count was 3,500 with polymorphonuclears 66 per cent (0-1-65), lymphocytes 20 per cent, monocytes 12 per cent, eosinophiles 2 per cent. Other laboratory findings: serum protein 6.9 per



FIG. 3. Roentgenogram showing a second constriction in the lower jejunum about 2 cm. in length and about 15 cm. distal to the narrowing demonstrated in Figure 2.

cent, albumin 4.1, globulin 2.8, euglobulin 0.3 per cent, serum calcium 9.0 mg. per 100 cc., serum nonprotein nitrogen 26 mg. per 100 cc., serum phosphatase 3.4 Bodansky units per 100 cc., serum cholesterol 136 mg. per 100 cc., serum bilirubin, negative.

On August 12, 1940 (approximately three months after operation) another gastrointestinal roentgen study was done. The barium column was seen to pass rapidly through the duodenum and into the jejunum to be temporarily arrested in the proximal jejunum about 8 or 10 inches distal to the ligament of Treitz. Here, a narrowed segment about 3 cm. in length was noted (Fig. 2). About 6 inches distal to this a second narrowed zone about 2 cm. in length was observed (Fig. 3). There was no obstruction. The motility of the small intestine as a whole was normal. There was hypertonicity of the lower ileal loops. Except for rather large gastric mucosal folds, no roentgenologic abnormalities were observed in the remainder of the gastrointestinal tract.

The patient returned to his home in Costa Rica. It was learned that on May 14, 1942, approximately one year after his hospital admission, the patient died. His death occurred on

the fifth day following an operation for attempted relief of episodes of intestinal obstruction recurrent over a period of six weeks. At this laparotomy, the Costa Rican surgeons described an ulcerous segment of jejunum just distal to the previous enterectomy. This contained a tumor completely obstructing the lumen of the jejunum. Two additional tumefactions were observed. The lesions were not examined microscopically.

*Pathological Findings.* Gross examination of the resected jejunum showed an ulceration with indefinite borders extending around the entire circumference of the intestine and measuring 2.7 by 3 cm. (Fig. 4). The jejunal wall was thickened in this region. The histological sections show normal intestinal wall ending abruptly where the mucosa is destroyed and replaced by granulation tissue infiltrated by enormous numbers of plasma cells together with a few lymphocytes. The plasma cells infiltrate the entire thickness of the jejunum and pass out into the mesenteric fat. Some of the regional lymph nodes of the mesentery are almost solidly filled with plasma cells. For the most part the plasma cells are of relatively normal appearance. A number of them, however, are multinucleated and they show mitoses on an average of one in every seven or eight high power fields (Fig. 5). The sections were interpreted as plasmocytoma of the jejunum causing superficial ulceration and with metastases in the mesenteric lymph nodes.

The recognition of plasmocytoma as a true neoplasm has been a controversial matter. Much of this is probably due to inconclusive knowledge of the nature, ori-



FIG. 4. The resected segment of jejunum opened along the antimesenteric border. The photograph shows the mucosal surface with the sharply circumscribed annular area of infiltration and ulceration.

gin and function of the plasma cell. Apparently it has a close relationship to the lymphocyte. Hellwig, in his review states, "the conception of the plasma cell as being a differentiated lymphocyte places the extramedullary plasma cell tumor in the disease entity of lymphoma." As in other lymphomatous lesions, difficulty arises in distinguishing between an inflammatory

or irradiation, or both, may effect a cure. If the lymph nodes or bones are involved the prognosis is poor. Some cases, however, show recurrence years after the removal of a primary tumor.

With respect to the small intestine the histopathological classification of plasma cell tumor may be especially difficult. The issue is particularly clouded by the fact



FIG. 5. Photomicrograph showing destruction of the mucosal glands and solid infiltration of all of the coats with masses of plasma cells which have also penetrated into the mesenteric fat. Inset shows the character of the individual cells.

and a neoplastic process. According to Hellwig, the histopathological character of the lesion is not important in predicting the clinical course. He found the site and gross appearance to be of more prognostic significance. Thus a tumor of the conjunctiva may pursue such a benign course as to be considered inflammatory, whereas a tumor of identical histopathology located in the airways or lymph nodes may be highly destructive and metastasize widely. Further, if the tumor is localized, excision

that collections of plasma cells can occur in chronic inflammatory conditions. Atypical forms of granulomatous lesions of the type seen in regional ileitis may be suggested. Certain features of our case and the cases described in the literature are of significance. The number of plasma cells, many of them in mitotic phases, appears too numerous to be explained on the basis of inflammation alone. In support of a neoplastic interpretation is the occurrence of plasma cells in such numbers with very few



lymphocytes, and without the presence of other inflammatory cells such as polymorphonuclear leukocytes, macrophages and other vascular elements commonly associated with inflammation. In Brown and Liber's case, groups of plasma cells were found within blood vessels without evidence of an enmeshing inflammatory thrombus. Of even more significance is the presence of large numbers of plasma cells within the regional lymph nodes justifiably interpreted as metastatic in nature. Hellwig stated further, "the extramedullary plasma cell tumor in spite of typical cell structure, may range from an entirely non-cancerous growth to a cancer of high grade," the predicted course depending more upon the localization and gross appearance. It would appear from the above and other cases that plasmocytoma of the small intestine pursues the clinical course of a malignant tumor with a tendency to ulceration, multiple areas of involvement, and metastases to regional lymph nodes.

#### COMMENT

The small intestine is not a frequent site of malignant tumor. Swenson tabulated 131 cases of both benign and malignant tumors of the small intestine from the files of the Presbyterian Hospital. Only 49 of these were malignant. Roentgenographic methods of examination are playing an increasing rôle in the diagnosis of these lesions. The value of the spot compression roentgenogram in demonstrating destruction of mucosal folds and the presence of ulceration is borne out in our case. Beyond the destruction of the mucosa and its connotation of malignancy, one cannot be specific as to the type of lesion. In this respect one feature of our case is impressive. This is the presence of multiple areas of involvement. Lymphosarcoma may also involve the intestine at more than one level. We have reviewed 15 cases of lymphosarcoma of the small intestine from the files of the Presbyterian Hospital. In 4 of these the intestine was involved at more than one site. It is significant that all of

these 4 were studied at autopsy and that of eight cases diagnosed by examination of surgical specimens or biopsies, none showed multiple areas of involvement. It would appear from this that earlier cases of lymphosarcoma are more likely to present single areas of involvement and that multiple areas occur as a later manifestation. In a recent review of lymphosarcoma of the intestines, Winkelstein and Levy<sup>10</sup> describe a case with involvement of the duodenum and several areas of proximal jejunum, and another case involving two areas in the terminal ileum. Occasionally other varieties of malignant neoplasm may show multiple areas of involvement. We have seen a case of metastases in the wall of the ileum, jejunum and one in the duodenum from an occult malignant melanoma. While multiple carcinoid tumors and metastatic implanting carcinoma occur, the lesions are usually too small to be detected roentgenographically. Adhesions may produce several narrow areas, varying in length, in which normal mucosal contours can be demonstrated by pressure roentgenograms. It may be necessary to differentiate malignant disease of the small intestine from narrowing due to inflammation. As suggested by Golden,<sup>2</sup> usually the constriction due to malignant disease is short, while that due to inflammation is longer. In many cases, however, the mucosal surface of the constriction as outlined by the barium is similar in both conditions. For example, a solitary tuberculous ulcer might produce a short constriction with destruction of mucosal folds. This would be indistinguishable from a primary malignant tumor. A short inflammatory narrowing cannot be differentiated with certainty from malignant disease, nor a long malignant tumor from an inflammatory process.

#### SUMMARY

We have presented the case of a thirty-five year old man who had repeated intestinal hemorrhages over a period of three years. A gastrointestinal roentgen examination before operation showed evidence of a



narrowing in the jejunum interpreted as evidence of malignant disease. A series done after operation showed two areas of narrowing in the jejunum. Laparotomy revealed six constricting lesions in the jejunum. Histopathological examination of one of these showed an enormous number of plasma cells infiltrating all walls of the jejunum and also the regional lymph nodes. This is interpreted as plasmocytoma of the jejunum with metastases in the regional lymph nodes. A discussion of the relevant pathological findings is presented. We have commented upon the multiple areas of involvement as of significance with respect to roentgenographic diagnosis.

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# A STUDY OF THE RELATIVE IMPORTANCE OF THE CORTEX AND SPONGIOSA IN THE PRODUCTION OF THE ROENTGENOGRAM OF THE NORMAL VERTEBRAL BODY\*

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FOR several years, we have attempted to explain, upon anatomical grounds, the various roentgen shadows of human vertebral bodies.<sup>4,5</sup> This paper is a continuation of work started in 1929 and has for its purpose the following considerations.

1. The relative "shadow values" of the cortex and of the spongiosa of the vertebral bodies.
2. An explanation of the transverse markings seen in the lateral roentgenogram of 10 to 20 per cent of human vertebral bodies.

3. The minimum size of a lesion in the spongiosa detectable roentgenographically.

1. "*Shadow Values*" of Cortex and Spongiosa. The term "shadow values" is used to designate the relative importance of the cortex and spongiosa in producing the characteristic roentgenograms of vertebral bodies. Confusion exists as to the relative importance of these two components. Snure and Maner<sup>3</sup> contend that the cortex is largely responsible for vertebral roentgenograms, and that large portions of the spongiosa may be removed without being detectable. Lachmann,<sup>2</sup> in a study of the knee joint, finds that the cortex plays little part in the production of the roentgenogram. In order to determine the "shadow values" of vertebral body cortex and spongiosa the following experiments were made:

Fresh adult human lumbar vertebrae were obtained at necropsy and prepared as follows (Fig. 1): Three adjacent vertebrae were taken and labeled *A*, *B* and *C*. From *A*, the cortex was removed. From *B*, the soft tissues alone were stripped, this vertebra becoming a control for *A* and *C*. In *C* the spongiosa and soft tissues were removed, leaving but a cortical shell.

These vertebrae were immersed in the water phantom, and were roentgenographed under conditions designed to duplicate those obtained in a human subject of average size. A phantom consisting of an aluminum pail, of proved radiolucency, containing varying amounts of water, was used. The vertebrae were immersed at varying depths.

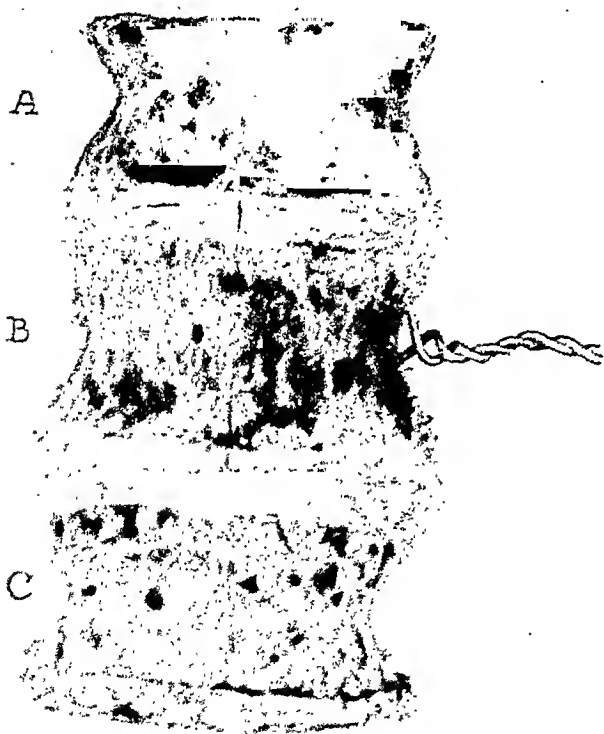


FIG. 1. Section of adult spine containing three lumbar vertebral bodies. *A*, soft tissue and cortex removed; *B*, soft tissue alone removed; *C*, soft tissue and spongiosa removed.

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For anteroposterior views, the pail was filled with water to a depth of 20 cm., and the specimen submerged to a depth of 8 cm. from the bottom (Fig. 2). For the lateral views, the pail was filled to a depth of 26 cm., and the specimen submerged to within 13 cm. of the bottom (Fig. 3). The exposure factors used were those for lumbar spine roentgenograms for a man of these anteroposterior and lateral dimensions.

A General Electric small focus tube, with rotating target, was used, the roentgenograms being made with the aid of a flat Bucky diaphragm. For the anteroposterior views, the exposures were at  $3\frac{1}{2}$  seconds, 50 ma., and 55 kv., the tube-film distance being 36 inches. For the lateral views, the exposures were at 7 seconds, 50 ma., and 65 kv., with the tube-film distance 34 inches. For the lateral views a medium sized cone was used.

As seen in Figures 2 and 3 the clear sharp outline present in *B* and *C* is lacking in ver-

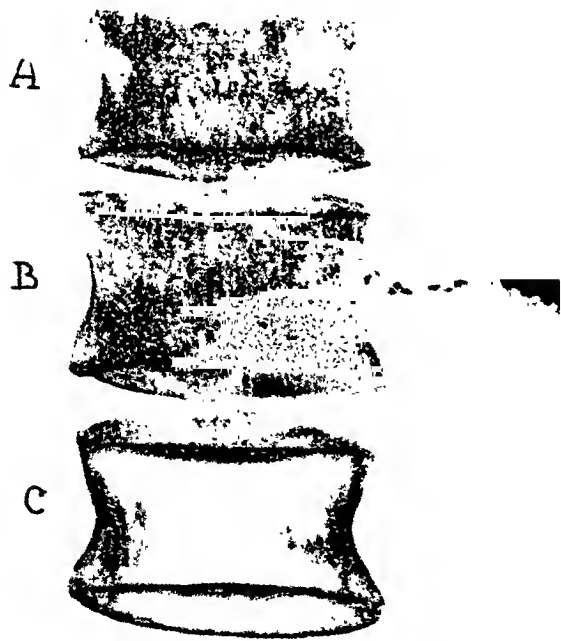


FIG. 2. Anteroposterior roentgenogram of vertebrae shown in Figure 1, made with bodies immersed in 20 cm. of water 8 cm. above the bottom of the container. *A*, soft tissue and cortex removed; *B*, soft tissue alone removed; *C*, soft tissue and spongiosa removed.

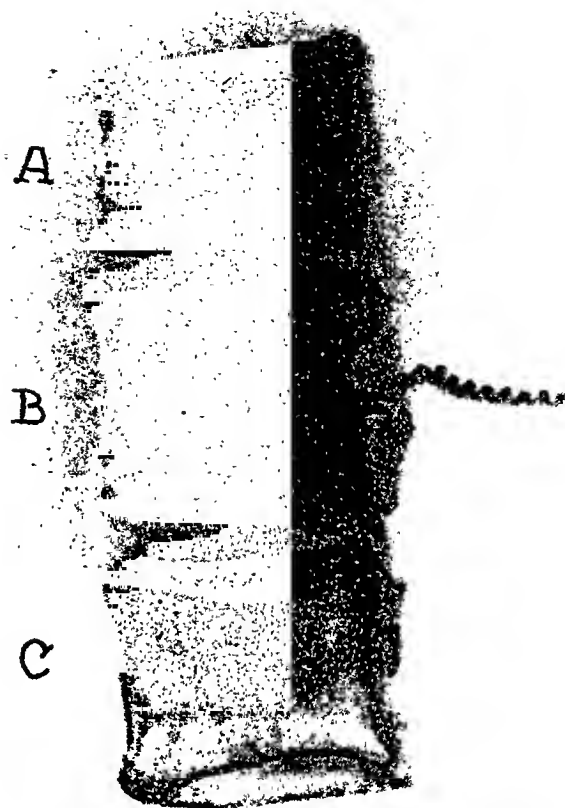


FIG. 3. Lateral roentgenogram of vertebrae shown in Figure 1 made with bodies immersed in 26 cm. of water 13 cm. above the bottom of the pail. *A*, soft tissue and cortex removed; *B*, soft tissue alone removed; *C*, soft tissue and spongiosa removed.

tebra *A*. However, the density of the bone in *A* and *B* is identical. The trabeculations are clearly visible in the vertebra from which the cortex has been removed, and cannot be distinguished from those of the control. Vertebra *C* (Fig. 2 and 3), however, presents an entirely different picture. The spongiosa of the vertebral body has been removed. Trabeculations are virtually absent; all that remains is a thin outline of the vertebra, the roentgen density of which is scarcely more than that of the water in which it is immersed except at its edges.

From this experiment the conclusion seems justified that the "shadow value" of the spongiosa is greater than that of the cortex in producing the characteristic roentgenogram of the vertebral body. It appears that the substance and detail of the roentgenogram are the result of the spongiosa, while the cortex contributes the sharp outline and a small amount of trabeculation which is almost entirely lost in the denser

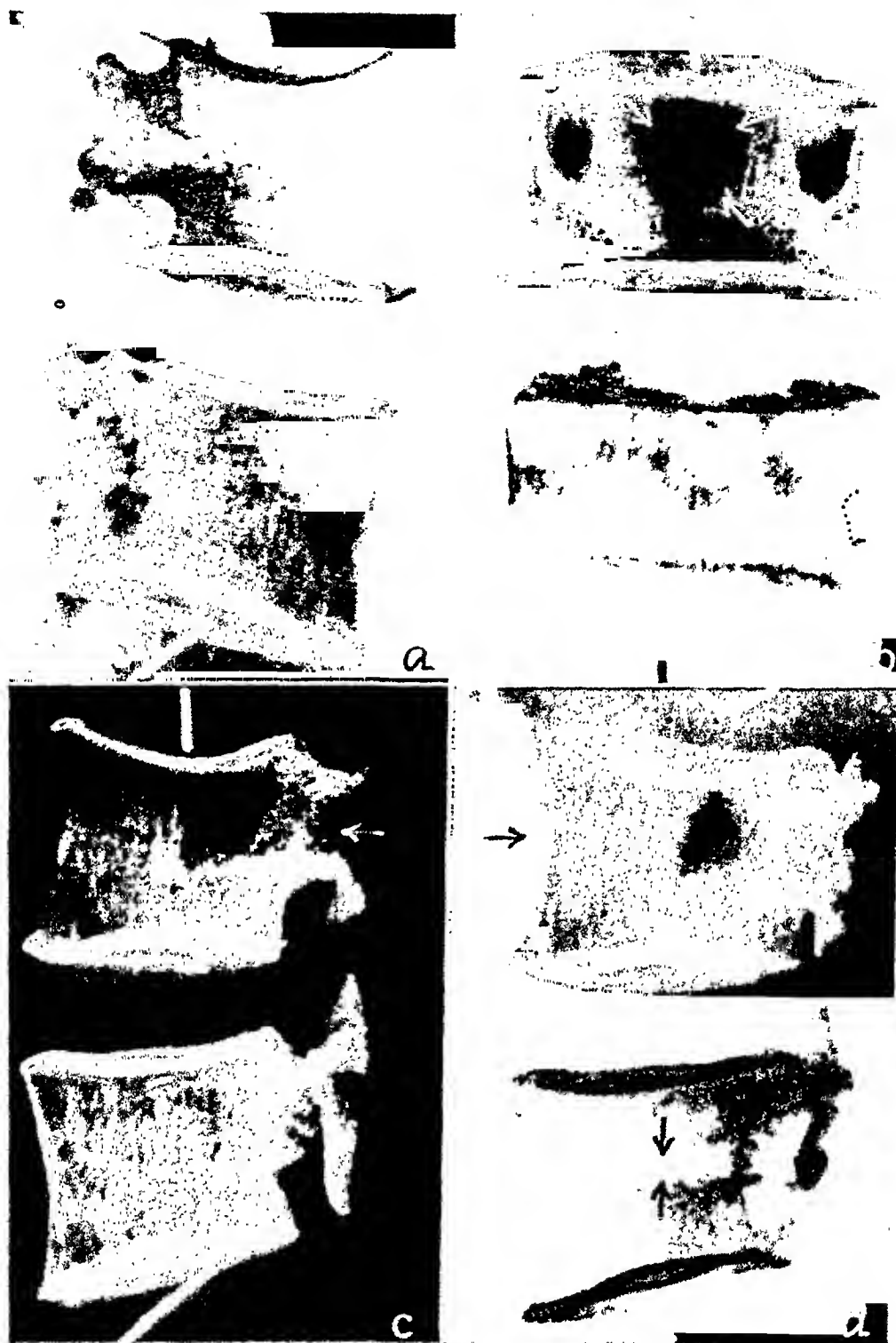


FIG. 4. Roentgenograms of lumbar vertebrae immersed in water. The roentgen technique is described in the text.

a, lateral roentgenogram of vertebrae before any artificial defects were made. Note that the vertebrae do not present "transverse markings."

b, anteroposterior roentgenogram of two lumbar vertebrae. A posterior defect was made in the spongiosa of the upper vertebra (arrow), and a lateral defect 5 mm. wide was made in the lateral wall of the lower vertebra (arrow).

c, lateral roentgenogram of the two vertebrae seen in b. Note that the transverse cortical defect cannot be seen, but the defect in the spongiosa of the upper vertebra is indicated by an arrow.

d, lateral roentgenogram of the two vertebrae after a central canal defect was made in the spongiosa of the lower vertebra. This defect, a series of decreased densities, may be seen clearly (arrow). The zone of decreased density seen in the upper vertebra (arrow) is due to a defect produced in the spongiosa.

and more pronounced markings of the spongiosa.

2. *Transverse Line.* In lateral roentgenograms of approximately 20 per cent of adult vertebrae there can be seen a transverse horizontal shadow extending through the center of the body. The presence of this shadow has frequently led to a diagnosis of fracture of the vertebral body.

Speculation upon the cause of the transverse marking has produced many explanations. Davis<sup>1</sup> considers the marking as due to diminished roentgen density the result of the venous sinusoidal system shown by us<sup>4</sup> to be present in the central area of the body.

In order that the cause and significance of this marking might be known the following examinations were made:

Two lumbar vertebrae were taken in which typical transverse markings were found absent in their lateral roentgenograms (Fig. 4, *a*).

It had been thought that a horizontal defect in the lateral walls of the vertebral body might explain the presence of the transverse marking. Consequently an artificial defect was made by removing a strip of cortex 5 mm. wide along one lateral wall. (This defect is clearly seen in the anteroposterior view in the left wall of the upper vertebra, Fig. 4, *b*.) Lateral roentgenograms of this vertebra taken after the cortical defect was made failed to show any shadow of lessened density (Fig. 4, *c*, lower vertebra). In view of the findings in this experiment it seems unlikely that a cortical defect is responsible for the production of the transverse markings seen so frequently in lateral vertebral roentgenograms in patients.

The same vertebra upon which the cortical defect was made was taken and by means of a small mastoid curette, introduced through the posterior foramina, an anteroposterior channel was cut through the center of the spongiosa. This channel was approximately 3 mm. in diameter. A lateral roentgenogram of this vertebra (Fig. 4, *d*, lower vertebra) now showed a transverse shadow of lessened density corresponding in position to the artificial de-



FIG. 5. Cut surface of two lumbar vertebrae showing central defects made in spongiosa. The upper vertebra shows a posterior defect in the spongiosa which measures 12 by 8 by 12 mm. The lower vertebra shows a 3 mm. diameter horizontal defect made through the center of the spongiosa. Cortical defect of lower vertebra cannot, of course, be seen.

fect in the spongiosa. (The actual defect is shown in the lower vertebra, Fig. 5.) The roentgen appearance is one of lessened density and corresponds to that of the "transverse markings."

To show that defects in the spongiosa register in roentgenograms, a defect was made in the upper vertebra (Fig. 4, *b*, *c*, and *d*). This defect, as in the case of the central channel, was made by a mastoid curette introduced through the posterior foramina. The defect measured 12 by 8 by 12 mm. and was made in the posterior third of the spongiosa below the anteroposterior midline. This defect is seen clearly in all subsequent roentgenograms. (Its gross appearance is shown in Fig. 5—upper vertebra.)

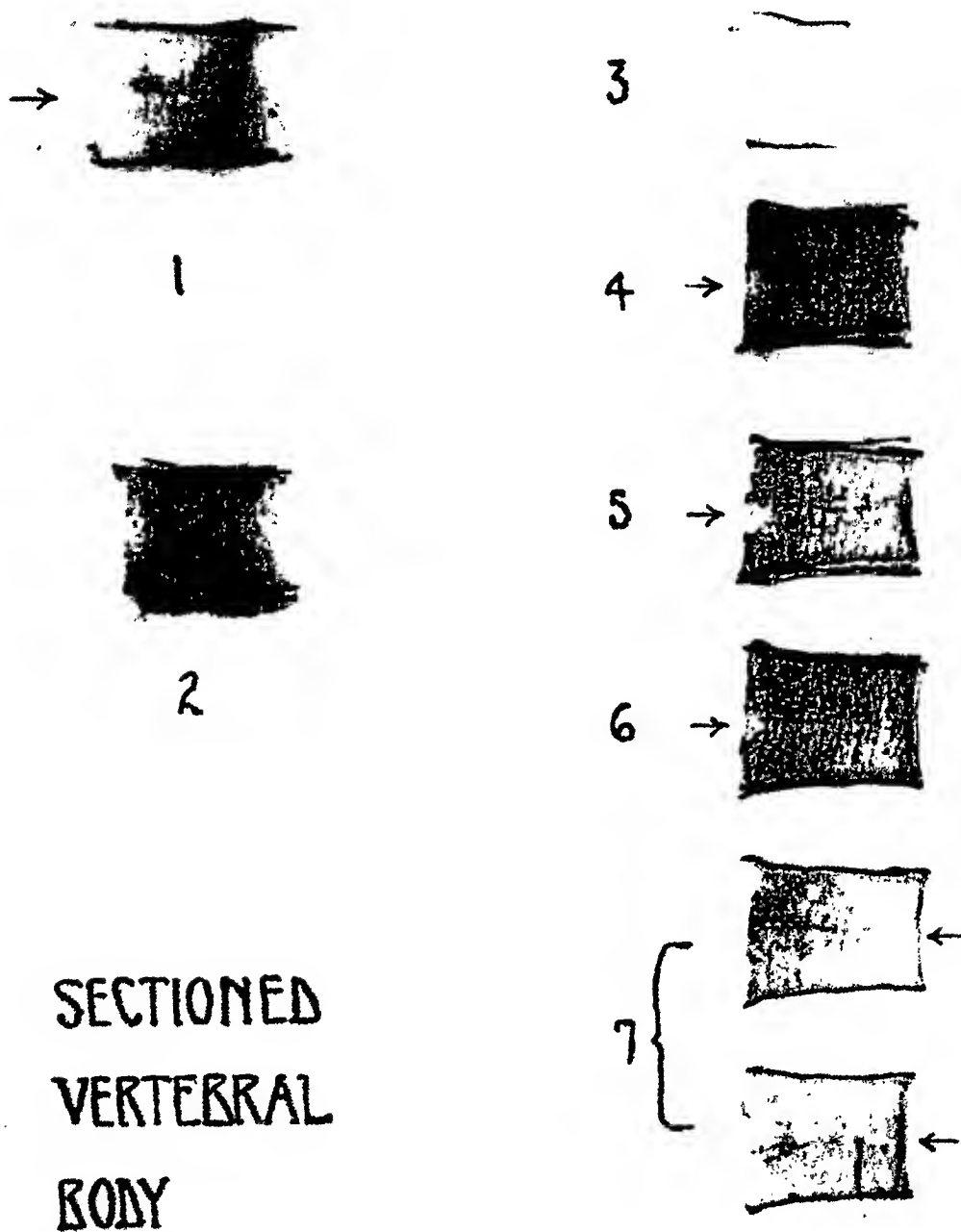


FIG. 6. Lateral roentgenogram of a vertebra taken in air. 1, vertebra before sectioning—showing transverse marking; 2, vertebra after sectioning; 3, two lateral or cortical sections; 4, five central sections; 5, three central sections; 6, two central sections; 7, two central sections (separated).

In order to localize further the cause of normal "transverse markings" the following investigation was made:

A roentgenogram of a normal adult lumbar vertebral body was made in the lateral position (Fig. 6, 1). The transverse markings are visible (arrow). This vertebra was then cut into seven parallel sections in its sagittal plane (Fig. 7). The sectioned vertebra

was reconstructed and roentgenographed (Fig. 6, 2). The transverse marking is not seen as well as in Figure 6, 1.

The two lateral or cortical sections were removed and placed together. A lateral roentgenogram of these two sections failed to show the presence of the transverse marking (Fig. 6, 3).

The five remaining sections were then

placed together and a lateral roentgenogram showed the presence of the central transverse marking (Fig. 6, 4).

The next two lateral sections were removed and the remaining three central sections showed in the lateral roentgenogram the transverse marking more clearly than in the preceding roentgenograms other than that of the intact vertebra (Fig. 6, 5).

The more lateral of the three sections was removed and the two central sections continued to show in the lateral roentgenogram the transverse marking (Fig. 6, 6).

The two central sections were examined separately and each showed in the lateral roentgenogram the transverse marking (Fig. 6, 7). In neither section was the marking as clear as when the two sections were examined in apposition.

From the foregoing investigation it can be concluded that the "transverse" marking seen in lateral roentgenograms of the intact vertebral body is produced by the peculiar structure of the central area of the body.

More detailed examination of the "transverse" marking, especially that seen in the roentgenogram of the two central sections, shows four characteristics.

1. Posterior conical notch shadow.
2. Central area of lessened density.
3. Two narrow bands of increased density, one bordering the area of lessened density above, the other below.
4. Decrease in the number of cortical bone trabeculae extending across the area of lessened density.

Explanation of these characteristics is made upon an anatomical basis.

As shown in a previous report<sup>4,5</sup> the posterior conical notch shadow is produced by lateral projection of the posterior vascular foramen.

The central area of lessened density corresponds in location and size to the central reservoir of the sinusoidal system shown previously to exist within the central structure of the vertebral body.

The two narrow bands of increased density bounding the central area of lessened

density above and below correspond to horizontal trabeculae present in these sites. These bone septa approach the texture of cortical bone plates. Posteriorly they are continuations of the walls of the posterior foramen. As they extend anteriorly they diminish in thickness and breadth and consequently in roentgen density.



FIG. 7. Anterior view of lumbar vertebra sectioned in the sagittal plane. This is the vertebra that is shown in Figure 6.

In view of the foregoing, it can be definitely stated that the transverse markings seen in the lateral roentgenograms of many normal adult human vertebral bodies are due to the presence of an especially well developed sinusoidal reservoir. This finding is in general agreement with Davis' conclusions. Davis,<sup>1</sup> however, assigns to "blood vessels" and "blood vessel channels" within the bodies of the vertebra the causative role. We state that sinusoidal spaces and the central sinusoidal reservoir present in the bodies are responsible. The difference between these two explanations is one of histologic interpretation of the structures concerned.

Parenthetically, it may be stated that we believe that lateral roentgenograms of all normal vertebral bodies would show transverse markings if the exposure factors were correct or if the vertebra could be examined outside of the body. In practice one observes these markings more often in the



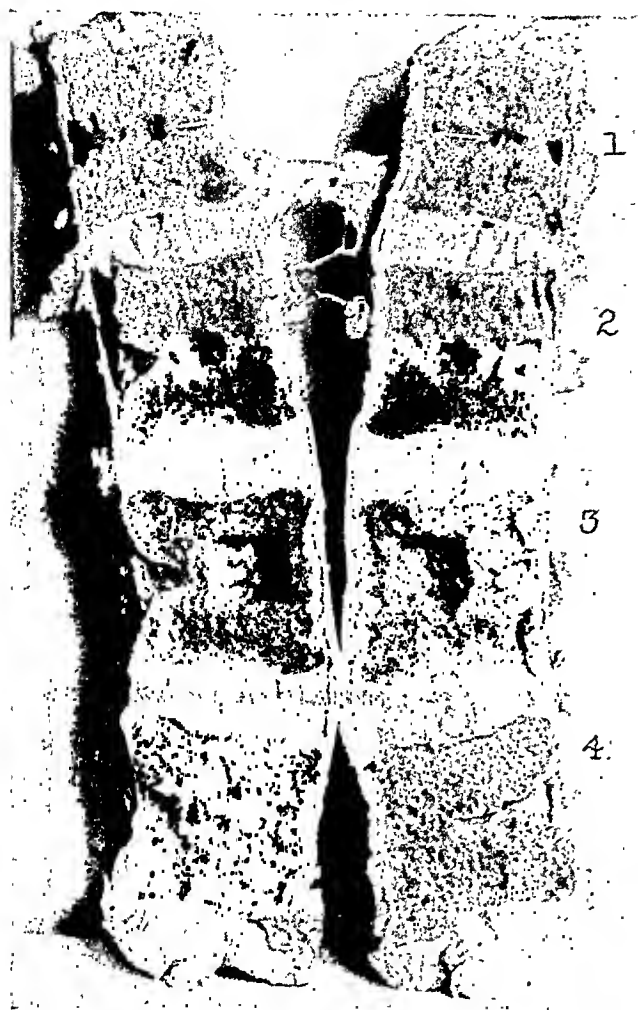


FIG. 8. Sagittal bi-section of four lumbar vertebrae, hinged by fibrous tissue at their anterior surfaces. The first three vertebrae, from above down, have had cuboidal defects made in the central portion of the spongiosa. Size of defects: 1—3 by 4 by 5 mm.; 2—4 by 6 by 9 mm.; 3—9 by 10 by 10 mm. The conical defects present in the posterior portions of all vertebrae are normal and are the posterior foramina or "notches."

dorsal vertebrae where roentgen-ray contrasts are greater. Overlying tissues and less well developed central sinusoidal reservoirs tend to lessen the definition of the transverse markings in lateral roentgenograms.

3. *Minimal Size of Vertebral Body Defects Recordable by Roentgenography.* The next problem is concerned with determining how small a defect made in (a) cortex and in (b) spongiosa will register upon roentgenograms taken under experimental conditions approximating the normal.

A section of normal adult human spine

composed of four lumbar vertebrae was bivalved in the sagittal plane. Defects were made in the spongiosa of the three upper vertebrae and a cortical defect in the lower vertebra (Fig. 8 and 9). The two halves of the section were approximated and fastened together. Roentgenograms were taken with the vertebrae immersed in water in accordance with the technique described in the first part of the paper.

(a) *Cortical Defects.* As shown previously, a groove cut in the cortex of the lateral wall of a vertebral body can be recognized in an anteroposterior but not in a lateral roentgenogram (Fig. 4, b and c).

The cortical defects made in the lateral walls of the lowest vertebra, as shown in Figure 9, measured 10 by 10 mm. These defects, though large and superimposed, failed to be shown in either anteroposterior or lateral roentgenograms (Fig. 10, 4).

(b) *Spongiosal Defects.* The defect made in the spongiosa of the uppermost vertebra



FIG. 9. External view of vertebra shown in Figure 8. On the lowest vertebra cortical defects measuring 10 by 10 mm. have been made in the lateral walls. These defects are so placed as to superimpose when the bisected column is closed.

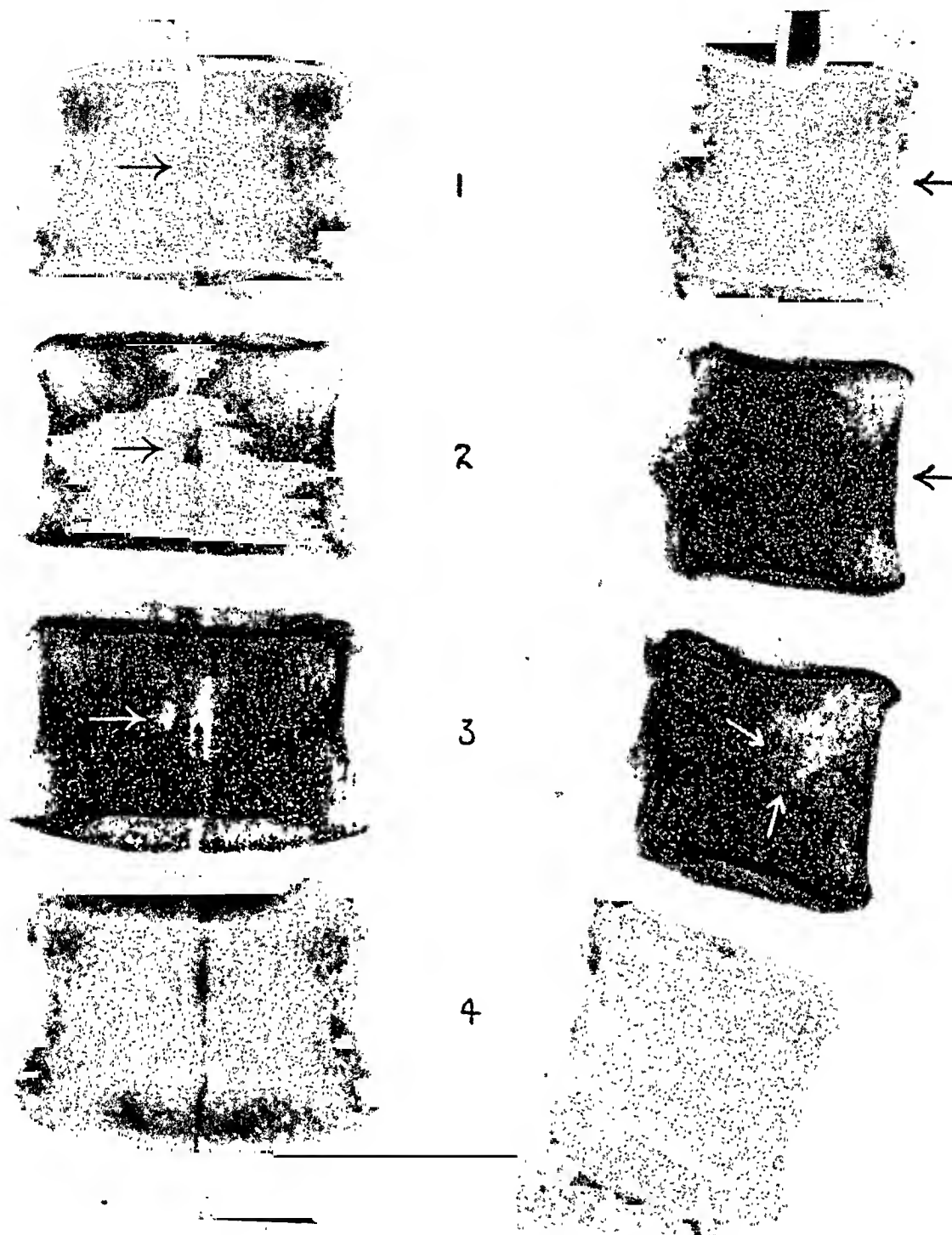


FIG. 10. Anteroposterior and lateral roentgenogram of the vertebra shown in Figures 8 and 9. Vertebrae immersed in water.

(1) measured 3 by 4 by 5 mm. That of 2 measured 4 by 5 by 9 mm. and 3, 9 by 10 by 10 mm.

In the anteroposterior roentgenogram the defects in all the upper three vertebrae are apparently shown (Fig. 10). In the case of vertebrae 1 and 2 the defects, as shown in Figure 8, are on the same axis as the posterior foramina. This positional arrangement results in shadow intensification in the anteroposterior roentgenograms.

The central defect in vertebra 3 is conclusively shown in the anteroposterior roentgenograms of this vertebra.

In the lateral roentgenogram of these vertebrae the central defect is clearly seen in vertebra 3. Knowing that a defect is present in vertebra 2 a corresponding shadow can be seen in its roentgenogram. A faint central shadow can be seen in the lateral roentgenogram of vertebra 1.

It is highly questionable whether the

central shadows in the lateral roentgenogram of vertebrae 1 and 2 would be detected were it not known that defects in the spongiosa of these vertebrae were present.

In conclusion, it can be said that large defects of the lateral cortex are not recorded in roentgenograms, and that much smaller defects of the spongiosa are clearly recorded by roentgenograms especially when they are superimposed upon anatomic shadows of decreased density.

These studies explain why in many instances it is difficult to demonstrate metastatic lesions whether of malignant or infectious origin even in the presence of strong clinical evidence that a lesion may be present. Likewise, in practice one not infrequently has to deal with confusing shadows of other structures.

#### SUMMARY AND CONCLUSIONS

A series of experiments is described in which the following problems were investigated:

1. The relative importance of the cortex and spongiosa in the production of the roentgenographic shadow pattern of the normal vertebral body.

2. The source of the "transverse line" seen in a high percentage of normal vertebrae.

3. The minimal size of vertebral body de-

fects recordable by roentgenography, and whether such defects are best visualized when present in cortex or spongiosa.

The following conclusions were reached:

1. The spongiosa is the more important component in the production of the roentgenographic shadow pattern of the normal vertebral body.

2. The "transverse line" is due to the presence of a well developed sinusoidal reservoir located within the spongiosa, and the cortex plays no part in the production of this marking.

3. Large defects of the lateral cortex are not recorded in roentgenograms, and much smaller defects of the spongiosa are clearly seen.

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# PSEUDARTHROSIS, SYNCHONDROSIS AND OTHER ANOMALIES OF THE FIRST RIBS\*

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THE roentgenologist sees many variations and anomalies of the ribs, but only rarely in connection with any symptoms. Occasionally, cervical ribs are found, but scarcely ever are they associated with neurological symptoms. Other anomalies of the ribs, especially the first ribs, only

0.15 per cent of 38,105 cases, and of these, 35 per cent were cervical ribs. Anomalies of the first rib were found by Todd<sup>14</sup> to occur in something like 1 per cent. Asymmetry of development is probably the most frequent normal deviation of the first ribs (Fig. 1). Next is failure of ossification of



FIG. 1. Anterior portion of the left first rib is hypoplastic.

sporadically require diagnostic attention. The roentgenologist may erroneously make an unsupportable diagnosis, however, if he is not familiar with the common developmental irregularities which are usually not associated with functional defects or actual disease.

## ANOMALIES

Steiner<sup>13</sup> found rib abnormalities in only

the anterior portion of the first rib, usually forward of the scalene tubercle (Fig. 2). Todd believed this resulted during embryological development from undue compression of the subclavian vessels in the groove which they occupy in the upper aspect of the first rib. Ribs so deformed are short and sometimes simulate cervical ribs, necessitating examination of the cervical and dorsal spine in order to make cer-

\* Nothing in this report is to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

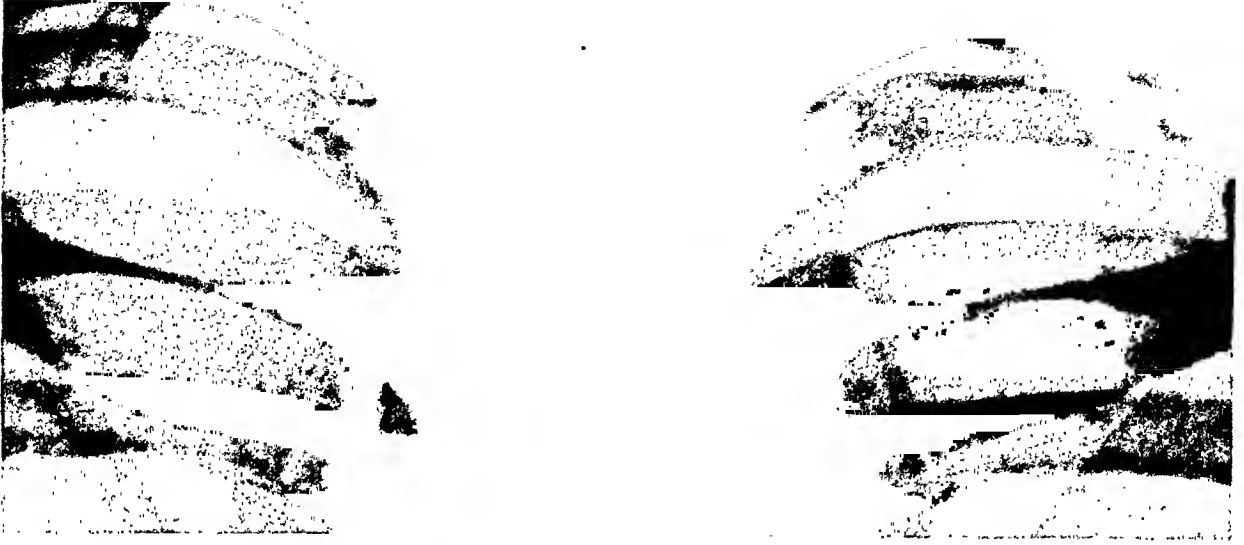


FIG. 2. Anterior portions of both first ribs are hypoplastic.

tain of the diagnosis. Partial instead of complete failure of ossification of the anterior portions of the first ribs is occasionally seen and the irregular ossification then observed is usually close to the manubrium, forming an incomplete sternoclavicular joint. Bifid first ribs are among the rarest unnatural aberrations, but incomplete foramen-like

defects, suggesting a prebifid stage is seen instead near the costochondral junction. Complete absence of the first rib has been described by Dreyfus-le Foyer, Augé and Brunet,<sup>5</sup> but no explanation of this defect was offered. Fusion of part or all of the first rib with the second rib is among the more frequently encountered peculiarities



FIG. 3. Fusion of the right first and second ribs.

(Fig. 3). Some authors have advanced theories linking these inconstant rib mutations to the evolution of disease in the underlying lungs and pleura, particularly tuberculosis. Since giving this hypothesis our close attention, never has a clear association been observed between tuberculosis or other disease in the upper lobes and these first rib anomalies.

#### CONGENITAL SYNCHONDROSIS

Andersen<sup>2</sup> covered rather completely the different normal modifications of first rib development and included a group of pseudarthroses of cervical and first thoracic ribs which more frequently than the other anomalies make an embarrassing demand on the roentgenologist in differentiating them from simple or pathological fractures. Some illustrations of these odd cases from our own experience are shown in Figures 4 to 8. These pseudarthroses tend to occur in the posterior third of the first rib. Von Sassen<sup>12</sup> believes they represent fractures due to muscle traction with subsequent pseudarthrosis. He disagrees with Frank-Pittowa<sup>6</sup> and Pickhan<sup>11</sup> who attributed this condition to a developmental anomaly akin to the avian costal articulation. Frank-Pittowa reported the case of an eighteen year old student with no history of injury who had a joint space dividing the first rib. The line of rarefaction had smooth contours and no callus was present.

This case is similar to ours (Fig. 5) in a patient who had no injury and no symp-

FIG. 5. Synchrondrosis of the left first rib in nineteen year old male. No history of injury and no symptoms were present.

toms in this area. Practically the same findings were observed in the case reported by Pickhan. These cases have in common (1) no history of injury, (2) no callus, (3) smooth edges and surfaces along the plane of dissolution and (4) no abnormal changes in the bone. For these reasons, it hardly seems likely that an old ununited fracture with pseudarthrosis is the correct explanation. A congenital synchrondrosis would seem to be a more appropriate designation. Similar synchrondroses are seen occasionally between the first and second ribs (Fig. 4).

#### PSEUDARTHROSIS

Failure to obtain a history of injury is in itself no proof against the existence of a fracture in a rib. So-called spontaneous fracture of a rib is not unfamiliar to roentgenologists, especially in patients with a violent cough, even in the absence of obvious lung disease. While these fractures may not be recognized at the time of their occurrence, the formation of a "lump," tender to touch and locally painful to the patient, especially when coughing, usually leads to a roentgen examination which almost invariably discloses callus formation. The roentgen appearance of such an incom-

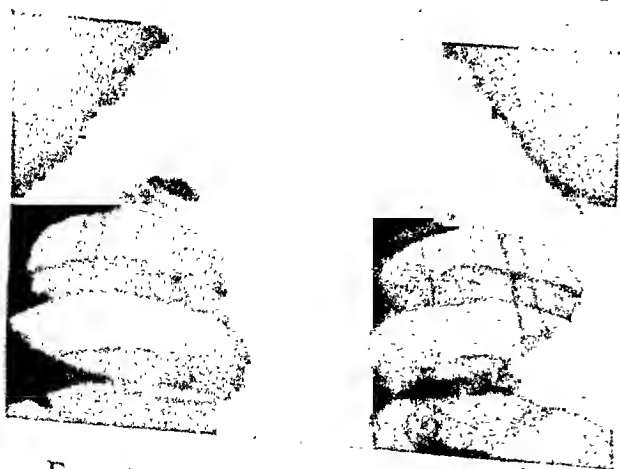


FIG. 4. Bilateral synchrondroses of first and second ribs.



FIG. 6. Pseudarthrosis not unlike an ununited fracture of the left first rib in a patient who gave no history of an injury. No symptoms were present, this finding having been incidental.

pletely united fracture is entirely different than the synchondrosis shown in Figure 5. Unrecognized "spontaneous" fractures of the first rib do seem to occur and by the time they are finally revealed in a roentgenogram, a pseudarthrosis may have formed.

In a recent examination of a thirty-one year old male, a serofibrinous pleurisy was found. A pseudarthrosis was discovered in the homolateral first rib and the possibility of a pathological fracture due to metastatic malignancy had to be eliminated before the diagnosis could be established. The patient could remember no injury and never did he have any complaints referred to this area (Fig. 6).

In another male, aged nineteen, a pseudarthrosis of the left first rib was found incidentally during an examination of his lungs. He could furnish no history of injury and he had no symptoms (Fig. 7).

Aitken and Lincoln<sup>1</sup> believe that fracture

of the first rib is possible as the result of muscle pull by the scalenus anticus. They quote the case of a twenty-nine year old male who carried a 50 pound load on his head up a ladder. An inadvertent jerk of the head caused a snap to be felt in his neck. Some pain developed, but this lasted only two or three days. While making up a bed twenty-six days later, the snap in the left supraclavicular area recurred followed by tingling in the fourth and fifth fingers. A fracture of the first rib was then found by roentgen examination, approximately at the site of the scalenus tubercle. The irregular fracture line and the presence of slightly calcified callus necessitated no differentiation from a congenital synchondrosis. Remarkable is the fact that fracture of the first rib, so well protected anatomically, can be fractured apparently by muscle pull, as is not infrequently the case in fracture of the lower ribs.

An excellent review of fractures of the first rib is to be found in Breslin's report<sup>3</sup> of 27 cases which included 22 gathered from the literature and 5 of his own. Re-examining the details of each case, there is little question about the diagnosis in those instances where there was direct and often violent trauma. Many of these suffered



FIG. 7. Pseudarthrosis of the left first rib in nineteen year old male. No history of injury and no symptoms were present.



shyness, backwardness in school and lack of normal interest in play. A sleepiness and mental sluggishness is said to often develop before the condition is recognized as more than a temperamental peculiarity. It is in just such cases as these that roentgen examination of the wrist proves its value. By study of the rate of ossification and the discovery that the appearance of the centers

as an index one must first accept the logic of the short-cuts. The pediatrician desires an indication of the extremes which, when discovered, can be subjected to further analysis. For his greatest convenience and as a quick evaluation and record of the stage of ossification, the figures chosen for the appearance of the centers may be posted in their chronological order as an

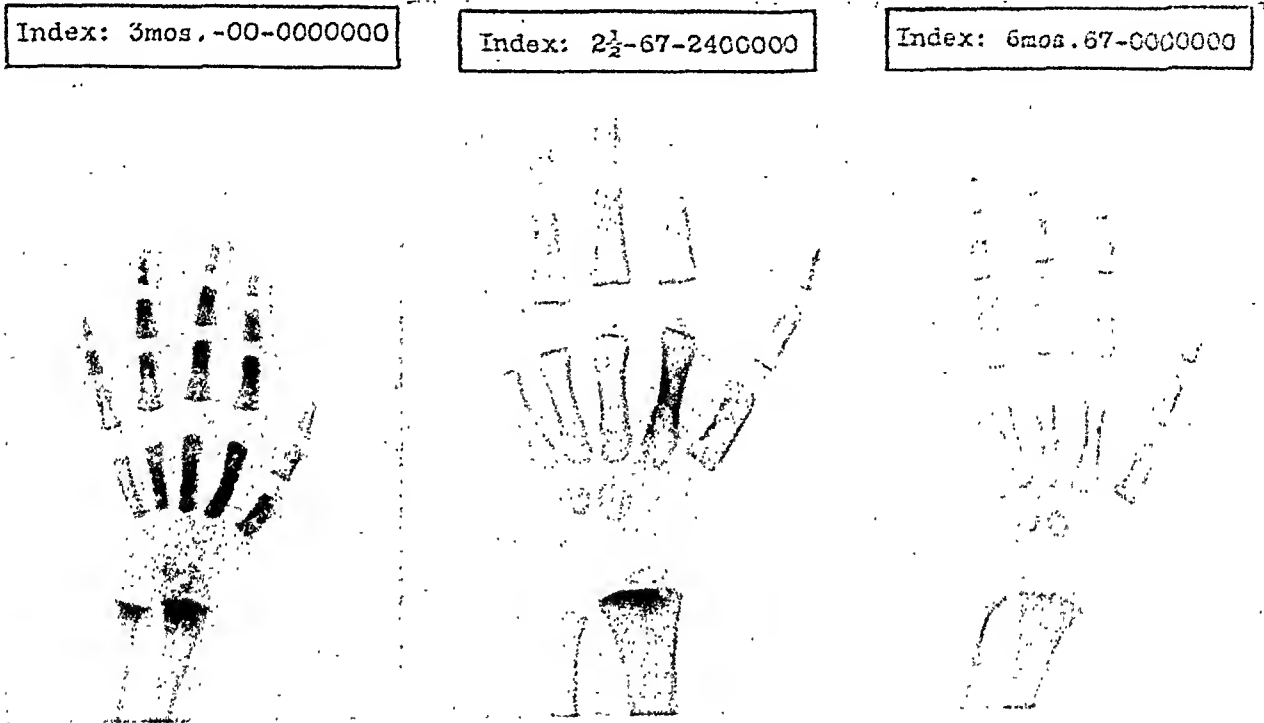


FIG. 2. Reproductions of roentgenograms taken during a pediatric clinic. A numerical description of the centers present is given in the form of the proposed "ossification index." Normal development is present in each case because all centers are present up to the actual age.

has been delayed, the need for substitution therapy will be proved and the progress of recovery under treatment observed.

#### OSSIFICATION INDEX

For rapid evaluation of the stage of ossification shown in any roentgenogram of a developing wrist, the use of a group of significant figures as an "ossification index" is proposed. As has been stated, this idea has been reached by a series of dogmatic short-cuts, first limiting the region of study to the wrist and then adopting a set of arbitrary age extremes for the appearance of the centers of ossification in that region. The taking of these liberties seems justified by the purpose back of it, but to accept this

index in which the key to interpretation is the actual age of the patient.

A diagrammatic representation of the order and the latest appearance of the ossification centers will assist in the computation of the index (Fig. 1). The index itself for the detection of delayed ossification is constructed by setting down the actual age followed by the figures for the centers actually present. These are placed in their chronological order and zeros substituted if any center has not yet appeared. A separation is made with hyphens between the figures representing months and those representing years. Thus the normal index for the full complement of centers at the age of seven years becomes 7-67-243677

(Fig. 1). When the actual age is less than seven, all centers up to that age should be present. For example; at the age of three: 3-67-2000000. With figures like these on the patient's record any deviation from the normal can be obvious without further reference to the roentgenogram.

It will also be seen that since this index is composed of figures representing the *latest*

assigned for the centers *up to the actual age* regardless of how many more may be present. Any index arrived at by inspection of a roentgenogram and found not to contain all of the figures up to the actual age of the patient is pathological.

Inasmuch as the discussion of the appearance of the ossification centers of the wrist has omitted mention of the pisiform bone

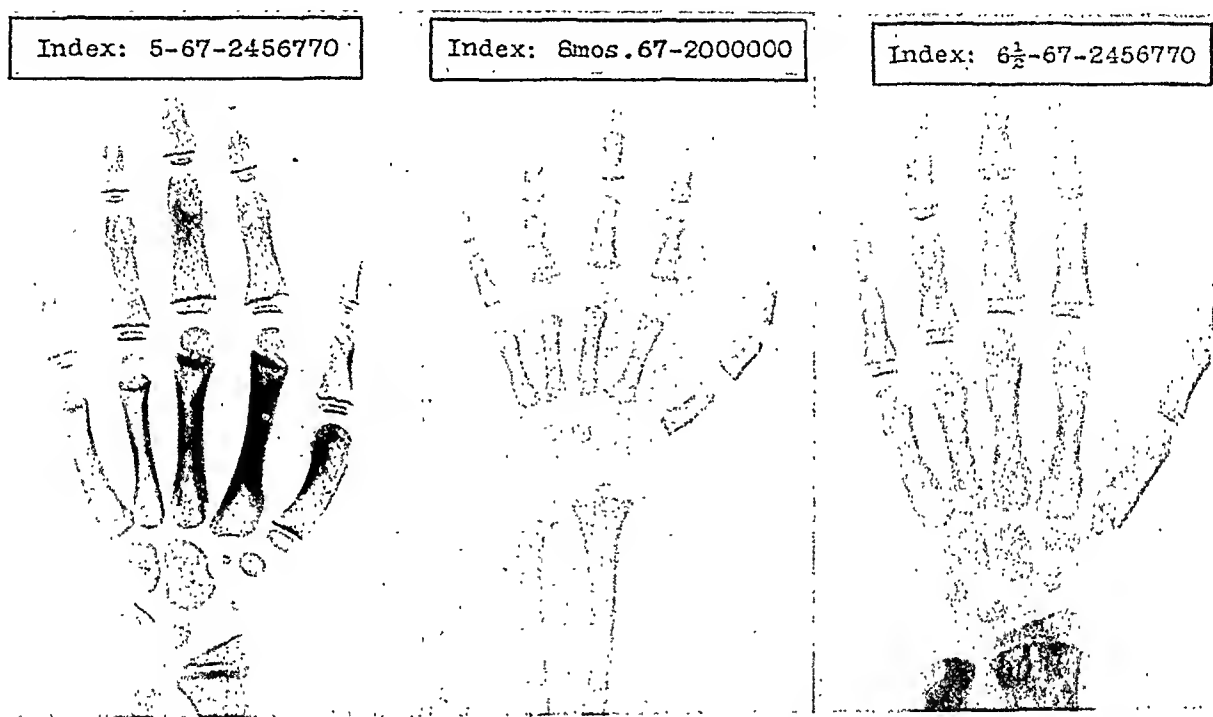


FIG. 3. Further application of the "ossification index" in the interpretation of bone development. All of these examples show centers whose latest possible normal appearance is later than the actual age. In spite of these variations, the index is normal and at the same time completely describes the findings.

normal appearance date of the centers, many cases will be found to have centers whose assigned figures are greater than the actual age. Such a case at the age of four may show an index of 4-67-2456000 indicating that this child might have an ossification age of six. Up to a certain point this is normal when considering only the *first appearance* of the centers. If, on the other hand, some evidence of obliteration of the epiphyseal lines is present in secondary centers, there may be an accelerated condition requiring study. However, in the majority of cases it can be said with certainty that the NORMAL OSSIFICATION INDEX is any group of figures, obtained in this manner, which includes all of the numbers

in the make-up of the index, it is felt that a simple anteroposterior flat roentgenogram will give all of the needed information. For uniformity it is also suggested that the left hand be used and the diagrammatic explanation of the index has been planned for these roentgenograms. However, if a view of the right hand has been taken, the negative can be turned over on the viewing box to give a quicker identification of the centers by direct comparison with the diagram.

A similar index with a slightly different type of interpretation may be prepared from the dates of the earliest normal appearance of the centers. This apparently would have less frequent application.

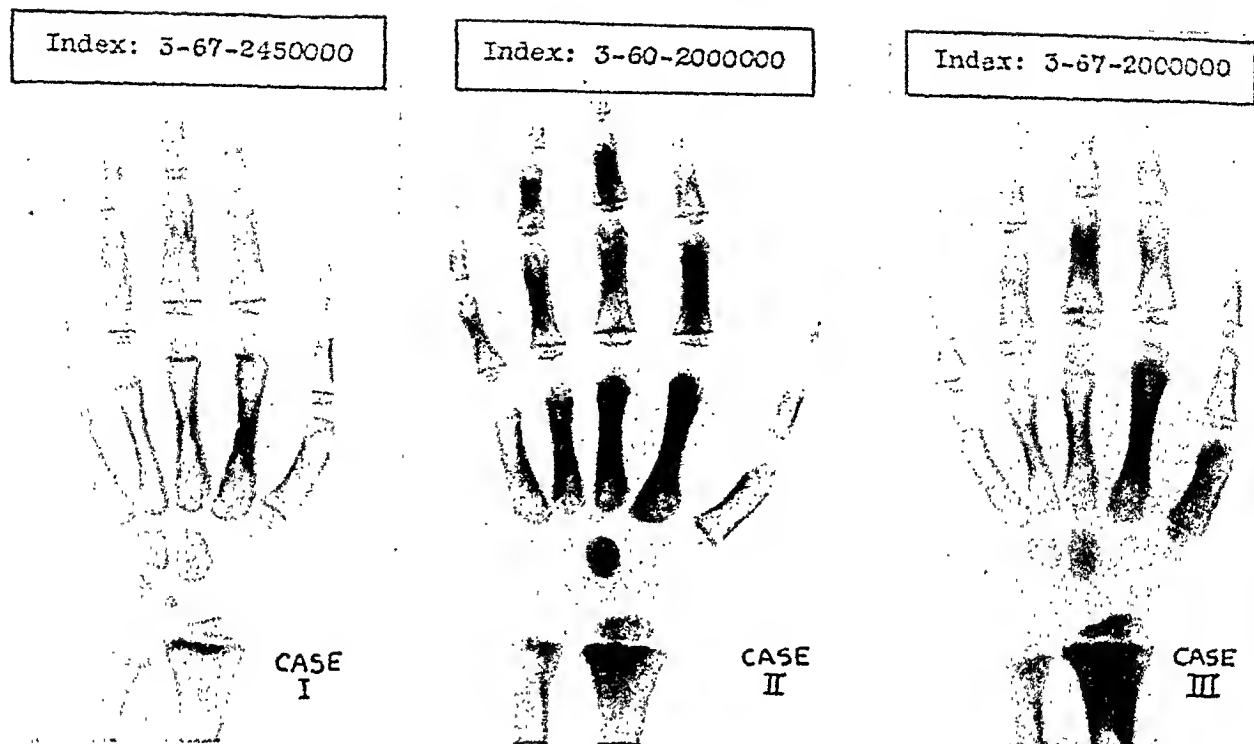


FIG. 4. Roentgenograms showing wide variation in the appearance of centers in 3 cases of the same age. In spite of these wide differences the index shows that Cases I and III are normal. Case II does not show all of the centers up to the actual age and is therefore abnormal. Reference to the "ossification index" immediately shows that the center which should appear before the seventh month has not developed (hamate bone).

#### SUMMARY

Brief reasons have been presented to justify a claim that a study of the rate of appearance of the ossification centers in the wrist is a workable means of checking upon the presence or absence of chronic metabolic disturbances in childhood. Arbitrary figures have been stated to indicate the earliest and the latest age for the appearance of each center as a means of detecting the extreme variations which are pathological. For the convenient use of these observations it had been suggested that the pediatrician construct an "ossification index" and several examples of the application to actual cases have been demonstrated (Fig. 2, 3 and 4).

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# POST-IRRADIATION BONE CHANGES\*

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SINCE the advent of high voltage roentgen therapy with increased dosage for certain malignant conditions, various tissue changes have been reported. Pulmonary fibrosis following irradiation of some cases of carcinoma of the breast, rectal and bladder ulceration following irradiation for pelvic malignancies, atrophy and disturbance of growth of soft tissues, and aseptic bone necrosis often followed by fracture have been reported.

## EFFECTS OF IRRADIATION ON BONE

Hillstrom,<sup>13</sup> whose untimely death prevented publication of his experimental data, found that on roentgen irradiation of the tibial epiphyses of two-weeks-old rabbits, measurable retardation of growth occurred in the bone when at least 40 per cent of a skin erythema dose was administered. He further observed that the retardation of growth was proportional to the increase in roentgen dosage and that divided doses are less effective than single equal doses. Hillstrom also found that roentgen rays, in certain doses, retard periosteal as well as endochondral bone growth, the latter being reduced from 84 per cent to 97 per cent of normal, by quantities of roentgen rays ranging from 100 per cent to 40 per cent skin erythema dose (1,000 r in air in one application being regarded as one skin erythema dose), the heavier the dose, the slower the growth. The ultimate shape of the bone or the duration of its growth is not noticeably altered by irradiation. Other experimental evidences of similar character have been presented by various authors.<sup>5, 8, 14, 30</sup>

Stevens<sup>31</sup> and Slaughter<sup>29</sup> have reported clinical observations of definite retardation of bone growth occurring after irradiation over the epiphyses of growing bones. We have had a similar experience in at least one instance.

## CASE REPORT

H. J., a male child, aged five months, was treated for a rapidly growing hemangio-endothelioma of the anterior aspect of the right thigh. The lesion measured 12.5 by 17 cm. at the time of the first roentgen treatment. A dose of 450 r in air was administered to the lesion at a distance of 50 cm., using a 190 kv. (peak) therapy unit, filtered with 0.5 mm. copper and 1 mm. aluminum.

The same dose was repeated three and eight months following the first treatment, making a total of 1,350 r to the lesion. Nine months following the last treatment the lesion had practically disappeared, leaving an indurated area 8 by 10 cm. over the right mid-thigh.

At the age of nine years the right femur was 3 cm. shorter than the left and 5 cm. smaller in circumference at the middle region of the thigh.

The right leg was 1 cm. shorter than the left and 1.5 cm. smaller in circumference.

One year later there was approximately an equal increase in the length of the femora and the circumference of the thighs; however, the difference between them remained the same. The bones of the legs also increased equally in length. While the circumference of the left leg increased 3.5 cm. in one year, the right increased only 1 cm.

The question arises as to whether this change in growth is entirely due to the irradiation of the distal femoral epiphysis itself or is partly due to the disturbance in the blood supply to the thigh and leg occasioned by the fibrosis resulting from the healing of the malignant lesion. It seems logical to assume that the change was mostly on a circulatory basis, since the bones of the leg are likewise of different lengths. Stevens' case had retardation in growth of the bones of the leg; treatments were also given over the thigh and pelvis, which revealed a similar lack of growth.

It has been well established that irradiation, especially when excessive, produces thickening, fibrosis, and finally obliteration of the blood vessels.<sup>7</sup> Furthermore, dis-

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turbances in circulation produce profound changes in bone structure, often resulting in death of the bone, manifested by so-called aseptic necrosis and bone infarcts. The clinical studies on the late effects of dislocation at the hip joint<sup>24</sup> and on caisson disease of bone<sup>4,15,27</sup> have abundantly borne out the experimental work.

Bone has a high calcium content, which produces a considerable amount of secondary radiation. Ewing<sup>7</sup> has shown histologically that irradiated bone presents widening and irregularity of lacunae and canaliculi with a partial loss of lamellar structure. Considerable time must elapse after irradiation for these changes to appear. It may take six months before a line of separation of the dead bone becomes apparent in the roentgenogram and the other bone changes become clearly visible.

The most commonly reported bone change resulting from irradiation is fracture of the neck of the femur. The anatomy of the femur and its blood supply are important considerations in estimating the factors which contribute to this result. The blood supply to the head and neck of the femur is limited largely to the arteries in the capsular ligament and the ligamentum teres. In a certain percentage of individuals there are no blood vessels in the latter ligament. The sharp limitation of the blood supply to the proximal end of the femur makes it peculiarly susceptible to aseptic necrosis and ununited fracture.

The neck of the femur varies in length and obliquity at different periods of life. In the adult it forms an angle of about 130 degrees with the shaft, but varies in inverse proportion to the development of the pelvis and the stature of the individual. In consequence of the widening of the pelvis in the female, the neck of the femur forms more nearly a right angle with the shaft than it does in males. Furthermore, the thickness of the neck is usually considerably less in females.

#### INCIDENCE OF IRRADIATION FRACTURES OF THE FEMORAL NECK

##### Spontaneous fracture of the femoral neck

among the general population occurs probably only once or twice in four or five thousand persons in the seventh decade and occurs more commonly in women than in men, at a ratio of three to one.<sup>28</sup> This is probably due to the osteoporosis and resultant weakening which accompany advanced age.

Roentgen injury to the bones of the pelvic girdle was not reported until 1927 when Baensch<sup>1</sup> of Leipzig cited 2 cases of fracture of the neck of the femur following roentgen therapy for carcinoma of the cervix and ovary respectively. Kropp<sup>17</sup> reported a similar case with fracture of the left femoral neck.

In 1932 Philipp<sup>25</sup> reported 5 cases of fracture of the neck of the femur following heavy irradiation to the pelvis through large fields including lateral fields. In none of his cases was there a history of trauma.

Dalby, Jacox and Miller<sup>6</sup> in 1936 added 14 cases of fracture of the femoral neck. In their series no direct radiation was given over the femoral neck nor were lateral fields over the trochanters used. Baker<sup>3</sup> reported a case of spontaneous fracture of the femoral neck following radiation therapy of the pelvis where no lateral fields were utilized.

Peck<sup>23</sup> found that out of 1,026 patients with malignant lesions in the pelvis who were seen in the Gynecological Neoplasm Conference, between July, 1931, and January, 1938, 28 were reported with spontaneous femoral neck fractures, an incidence of 2.7 per cent. He states that no exceptionally high incidence of fracture appears for any particular type of pelvic cancer.

Okrainetz and Biller<sup>21</sup> of the Montefiore Hospital in New York City added 1 case to the series of spontaneous femoral neck fractures. In this instance the roentgenographic changes in the femoral neck, which most likely represented bone necrosis, were thought to be due to metastasis, and further therapy was administered. The patient succumbed to the papillary adenocarcinoma of the ovary two years after occurrence of fracture of the right femoral neck. The complete pathologic description of this

femoral neck is given. The report states that there was "no evidence of metastasis," and "marked thickening of the walls of many blood vessels, some of which showed hyaline intimal necrosis, others complete obliteration." Furthermore, "new bone formation could not be seen."

Hight<sup>12</sup> reported the only case of fracture of the femoral neck in a male. His patient was fifty-nine years of age, and deep roentgen therapy was administered through portals in each groin for carcinoma of the penis; 1,600 r was given to each field. Four months after therapy, pain in the left hip developed, and a fracture was demonstrated roentgenographically.

Strauss and McGoldrick<sup>32</sup> reviewed the literature up to June, 1941, and were able to collect 55 cases of spontaneous fracture of the femoral neck following irradiation. They suggest that lateral fields are largely responsible for the accident.

Irradiation necrosis and fracture of other bones have been reported on many occasions. Among others, Kanthak<sup>16</sup> has observed "osteoradionecrosis" of the jaws. He states that "three definite factors seem to be conducive to this change, irradiation, infection, and trauma."

Slaughter<sup>29</sup> in 1942, reported on 8 cases of necrosis and fracture of the clavicle and ribs following irradiation for carcinoma of the breast. He estimated that the range of tissue doses delivered to the clavicle or ribs was 1,500 to 4,000 r, averaging approximately 2,000 r. Paul and Pohle<sup>22</sup> found that doses of 5,200 to 6,000 r per field were given in 10 patients who developed rib fractures following irradiation for carcinoma of the breast.

It is notable that irradiation fractures or osteitis of the pelvic bones, such as the pubic ramus, the sacrum, or the ilium, have not been reported, although the pubic bone particularly receives much larger amounts of radiation than does the femoral neck. The cases herein reported are unusual in that they include 3 cases (VI, VII and VIII) of multiple fractures and osteitis of the bones of the pelvis.

Since November, 1940, at the University of Minnesota Hospitals routine roentgenograms of the pelvis of all individuals referred for deep roentgen therapy of malignant conditions of the pelvis have been made before treatment and at yearly intervals thereafter. Furthermore, all patients treated since 1936 have been recalled and have been roentgenologically examined for evidences of injury of the pelvic bone. If symptoms develop, earlier studies are made. Thus far, no fractures or necroses have been demonstrated in patients entirely without symptoms, while several cases developed symptoms well before the appearance of roentgenographic evidence of necrosis or fracture. Subsequent roentgenograms demonstrated definite bone changes a month or two after the first complaint. We have had no postmortem studies to permit reports on the bone pathology.

Since the institution of high voltage roentgen therapy in July, 1926, to December, 1942, 1,904 patients have been treated for malignant conditions of the pelvis. This series includes:

<i>Cases</i>	
Carcinoma of the cervix.....	960
Carcinoma of the corpus uteri.....	195
Carcinoma of the ovary.....	208
Carcinoma of the prostate.....	376
Carcinoma of the bladder.....	165

There were 31 additional cases but these have been excluded, as they received treatment within the period from July 1, 1942, to December, 1942, and therefore a long enough interval had not elapsed for the usual roentgenographic changes to take place in the femoral head or neck. While most of the evidence indicates that six to eight months must elapse after irradiation before evidences of bone necrosis appear, we have seen 2 cases (I and III) in which definite roentgenographic changes appeared within five months.

Since the institution of our search for patients with bone changes incident to irradiation, 25 instances of bone necrosis or spontaneous fracture in 19 patients have been encountered. These represent 13 frac-



tures of the femoral neck in 11 patients (2 being bilateral), 2 cases of multiple fractures of the pelvis in 1 of which a fracture of the femoral neck developed later, 8 cases of definite sclerosis or areas of necrosis in the head or neck of the femur (1 being bilateral), and 1 case of sclerosis of the right ilium with fracture of the pubic rami.

During the period 1936-1941, 568 female patients were treated with irradiation for malignancies of the internal genitalia. Within this period were observed all but one of the cases detailed above. In this series, therefore, there were 18 patients with serious bone sequelae, or an incidence of 3.2 per cent. Two additional patients sustained fractures, but these followed serious injury, and preceding changes in the neck of the femur were not observed.

The statement of incidence is obviously not complete, inasmuch as it can be expected that more of the patients in this group will develop abnormal changes in the femur. This is demonstrated by 1 of our patients (Case v) who developed signs of necrosis almost six years after completion of the radiation therapy. It therefore might be more accurate to state that we can expect at least 3.2 per cent of females with pelvic cancer, who are subjected to radiation therapy, to subsequently develop disability from degenerative changes in the femur.

In 541 male patients treated for carcinoma of the bladder or prostate no fractures nor any other bone sequelae, which could be assigned to the irradiation, were encountered. We have seen 1 instance of fracture of the neck of the femur in a patient who had been treated with roentgen rays for carcinoma of the prostate, but the fracture followed a moderately severe injury and appeared to be purely on a traumatic basis.

It is notable that among the numerous reported cases of carcinoma of the prostate and bladder in males that were treated by heavy pelvic irradiation, there have been no instances of bone injury. The differences in the anatomy between males and females, the same factors which produce traumatic

fractures three times more often in females than in males, possibly the more restricted fields of radiation often used in the treatment of carcinoma of the prostate, and the shorter life span of the latter patients after irradiation may all be operative in effecting this striking sex difference.

#### PROBABLE FACTORS CONTRIBUTING TO BONE CHANGES

No satisfactory explanation can be given as to why one patient develops aseptic necrosis or a spontaneous fracture after deep roentgen irradiation while another who has received a similar dosage reveals no bone changes. It is also difficult to explain why necrosis and fracture occur in one femur only, although an identical dosage of roentgen rays was administered to both sides of the same pelvis.

The advanced age of some of our patients may be a contributing factor to many of the bone changes. However, one of the fractures developed in a patient who was only thirty-four years of age (Case vi). About half of the irradiation effects in our series occurred in patients between the ages of forty and sixty, which compares favorably with the age incidence of pelvic malignancy.

It is difficult to assess the importance of mild dietary deficiencies in the subsequent development of bone changes. Spontaneous fractures of bone do occur in patients whose diet is deficient in vital elements, especially calcium. In none of our cases did there appear to be a definite dietary deficiency.

The quantity of radiation applied is undoubtedly an important matter. That this is not the only factor is evident from an analysis of our cases. Five patients who were treated prior to 1938, when the total radiation dose was lower, developed pathologic changes in the femoral neck. However, in most of these patients two courses of deep roentgen therapy were given, even though there was no evidence of a residual malignant lesion. One patient developed bone changes after what is now considered to be a relatively small total tumor dose—

TABLE I  
SUMMARY OF CASES DEVELOPING POST-IRRADIATION BONE CHANGES

Case	Year of Treatment	Site of Cancer and Stage	Age	Weight	Calculated Tissue r Dose to Tumor	Interval to Fracture or Necrosis	Comment on Fracture or Necrosis
I M.B.	1940	Vagina	74	107	3,140 (over 31 days)	5 mo.	Fracture neck left femur with marked displacement. No treatment. Fracture united later. (See case report)
II L.A.	1938	Cervix III	58	162	2,760 (over 30 days)	30 mo. and 35 mo.	Bilateral fractures healed with McMurray osteotomies. (See case report)
III L.B.	1941	Cervix I	65	124	2,780 (over 21 days)	5 mo.	Roentgen evidence of sclerosis neck right femur. No disability. (See case report)
IV R.H.	1940	Cervix I	72	157	2,870 (over 34 days)	12 mo.	Roentgen evidence aseptic necrosis neck right femur. Some pain but able to be up and bear weight. (See case report)
V A.K.	1936	Cervix II	61	130	2,180 (1936) (24 days) left	21 mo.	Left—minor complaint pain on walking. Necrosis of head. Increasing difficulty
				2,180 (1937) (24 days) right	62 mo.	Right—same findings as left appearing three years later. (See case report)	
VI M.H.	1936	Cervix I	34	101	1,800* (over 26 days)	7 mo.	Fractures and necrosis of pelvic bones after injury
				1,800* (over 26 days)	24 mo.	Fracture neck femur without recent injury. (See case report)	
VII T.L.	1941	Cervix II	55	83	2,810 (over 23 days)	9 mo.	Multiple fractures 5th lumbar vertebra, sacrum, symphysis pubis without injury. (See case report)
VIII T.T.	1939	Cervix III	51	115	2,500 (over 25 days)	32 mo.	Sclerosis right ilium near sacroiliac joint and fractures of pubic rami without injury. (See case report)
IX M.B.	1935	Cervix III	58	130	1,540 (over 20 days)	65 mo.	Fracture neck right femur. McMurray osteotomy right femur
X H.B.	1936	Cervix III	48	140	1,860* (over 30 days)	48 mo.	Fracture left femoral neck and beginning sclerosis on right. McMurray osteotomy on left side
				1,860* (over 30 days)			
XI I.D.	1940	Cervix III	62	140	2,800 (over 27 days)	8 mo.	Fracture neck right femur. Treatment refused. Died 4 months later presumably of recurrent tumor
XII S.H.	1940	Cervix III	57	100	3,000 (over 24 days)	11 mo. and 13 mo.	Fracture neck right femur treated with body spica. Left femur showed osteoporosis and possible fracture. Treatment, bone graft
XIII L.B.	1940	Cervix II	48	100	2,940 (over 26 days)	15 mo.	Fracture neck right femur. Treated with bone graft
XIV B. McM.	1937	Cervix III	57	124	2,080* 2,080* (over 30 and 24 days)	16 mo.	Slight fracture neck right femur. Some pain but not incapacitating
XV I.B.	1938	Cervix II	64	125	2,480 (over 28 days)	12 mo.	Aseptic necrosis head left femur. Incapacitated by pain in left hip. McMurray osteotomy left femur

TABLE I (Continued)

Case	Year of Treatment	Site of Cancer and Stage	Age	Weight	Calculated Tissue r Dose to Tumor	Interval to Fracture or Necrosis	Comment on Fracture or Necrosis
XVII M.S.	1940	Cervix II	48	160	2,420 (over 30 days)	7 mo.	Sclerosis and necrosis neck right femur. Patient died of recurrent carcinoma
XVI H.D.	1937	Corpus II	68	196	2,440** (over 29 days)	9 mo.	Fracture neck left femur. Treated with bone graft
					2,340** (over 13 days)		
XVIII J.S.	1939	Cervix I	48	125	2,540 (over 25 days)	36 mo.	Fracture neck right femur. Marginal sclerosis left femoral neck. No special treatment to December, 1942
XIX L.N.	1940	Corpus	66	160	2,850 (over 23 days)	24 mo.	Fracture neck left femur. Treated with bone graft

\* Second course of roentgen therapy given approximately one year after initial treatment.

\*\* Second course of roentgen therapy given three years and nine months after initial treatment.

1,540 tissue roentgens (Case IX). Nevertheless, the incidence of bone changes increased appreciably after the institution of more intensive therapy.

Since 1938 the treatment of pelvic malignancies in women has been well standardized in our clinic. In carcinoma of the cervix and corpus a total calculated depth dose is given, amounting to 2,700 to 3,000 tissue roentgens to the region of the lesion. A 220 kv. (peak) deep therapy unit is utilized with 15 ma. intensity, filtered with 1 mm. of copper and 1.2 mm. of aluminum (half-value layer 1.75 mm. of copper). The focal skin distance is 60 cm. on the lateral and oblique fields and 70 cm. for the anteroposterior fields. Six or eight pelvic fields are utilized, depending upon the size of the pelvis. A course of treatments is given over a period of twenty-four to thirty days.

Radium emanation follows immediately after completion of roentgen therapy to the pelvis. Usually five fields are utilized for the radium applications two of which are in the uterus and three in the vagina, delivering a total of 5,000 mg-hr. in a period of one hundred hours. Where the uterus or vagina will not permit the use of five fields, the total dose is decreased to 4,000 or 4,500 mg-hr., but the application is kept constant at one hundred hours.

Most authors agree that the radium application probably plays a very minor rôle in the development of post-irradiation bone changes because of the distance of the radium from the femora. However, the possible effect of the emanation on the pelvic arteries, causing a decrease or complete obliteration of the blood supply, must be considered as an accessory factor.

#### CLINICAL FINDINGS

The usual complaint of most patients is a mild aching pain in the affected bone, which may radiate to the anterior thigh. The pain at first is not incapacitating and in some cases may never cause total disability. However, in our series most of the patients have eventually become somewhat incapacitated, and some have required orthopedic interference.

In such cases as developed a complete fracture and necrosis of the femoral neck there was revealed the usual shortening of the femur, the coxa vara deformity at the hip, and the external rotation of the lower extremity.

#### TREATMENT

The method of treatment of spontaneous fractures of the femoral neck has depended upon the extent of the pathologic condition.

Where a clear fracture and necrosis were demonstrated on the roentgenograms, a McMurray osteotomy of the femur was performed. In 1 instance with the fracture in good position, a tibial bone graft was introduced into the neck of the femur. A similar graft was inserted in another case where it appeared that a fracture was imminent; however, this was done after the patient had developed a definite fracture in the opposite femoral neck. No specific treatment has been devised for patients with bone necrosis. Because of the usual pain, the activities of most of these individuals are curtailed involuntarily.

Table 1 summarizes the entire group of patients with post-irradiation bone changes in the femur or pelvis.

A study of these cases reveals a number of salient findings. While symptoms usually appeared prior to clearly demonstrable roentgen findings, it was possible, especially when roentgenograms had been obtained at the time of treatment, to predict impending fracture by the sclerotic changes in the femoral neck (Fig. 2*a* and 3*a*). Careful study of the trabeculae in most instances will reveal areas of increased density. Especially significant is a transverse line of density running across the femoral neck, occasionally accompanied by small areas of rarefaction (Fig. 7*a*). Likewise the changes in the head of the femur may be detected in their earliest stages if repeated routine examinations are made (Fig. 4 and 5). The head becomes slightly denser than normal, the detail of the trabeculae is lost, and then areas of rarefaction appear. Similar changes are found in the acetabulum neighboring the joint (Fig. 4*b* and 5*b*). In 1 instance (Fig. 3*b*) a complete defect in the head of the femur was the first observation. The resemblance to the progressive changes of osteochondrosis of the femoral head (Perthes' disease), to those found in post-traumatic aseptic necrosis and in caisson disease is striking. It tends to bear out the theory that all have a common origin in vascular changes.

Within this group of cases there were 3

of unusual interest which are reported in detail below. In all of these (Fig. 7, 8 and 9) multiple fractures of the pelvis were found involving the sacrum, and the pubic rami. These fractures occurred in 1 case with some trauma, in the other 2 without apparent trauma. They were unusual in their appearance and produced minimal symptoms, considering the extent of the bone injury. In 2 of these the possibility of osteoclastic metastases to the pelvis was considered, but the true diagnosis was established by the course of events.

#### CASE REPORTS

The following cases are reported in greater detail, as they illustrate the findings obtained:

**CASE I.** M. B., aged seventy-four was admitted in May, 1940, with a diagnosis of squamous cell carcinoma of the vagina. A series of high voltage roentgen treatments was administered, yielding a calculated tumor dose of 3,140 r. Radon seeds were implanted at the periphery of the lesion, 1,128 millicurie-hours being the total dose.

In November, 1940, five months after therapy, the patient noticed pain in her left hip and thigh. There was no history of injury. The first roentgenogram made in December, 1940, revealed a fracture of the left femoral neck with marked malposition. No specific therapy was given, and in October, 1941, the patient was walking without difficulty; roentgenograms revealed good healing at the fracture site.

*Comment.* This patient presents the typical findings in a case of irradiation fracture. The appearance of pain without antecedent injury, the consequent occurrence of disability, and finally the roentgen demonstration of a fracture are characteristic. Roentgenograms had not been made prior to the occurrence of the fracture. Note the appearance of symptoms within five months after irradiation and the demonstration of the fracture one month later.

**CASE II.** L. A., aged fifty-eight, in November, 1938, was found to have a squamous cell carcinoma of the cervix uteri. The dose given was 2,760 tissue roentgens to the tumor by high

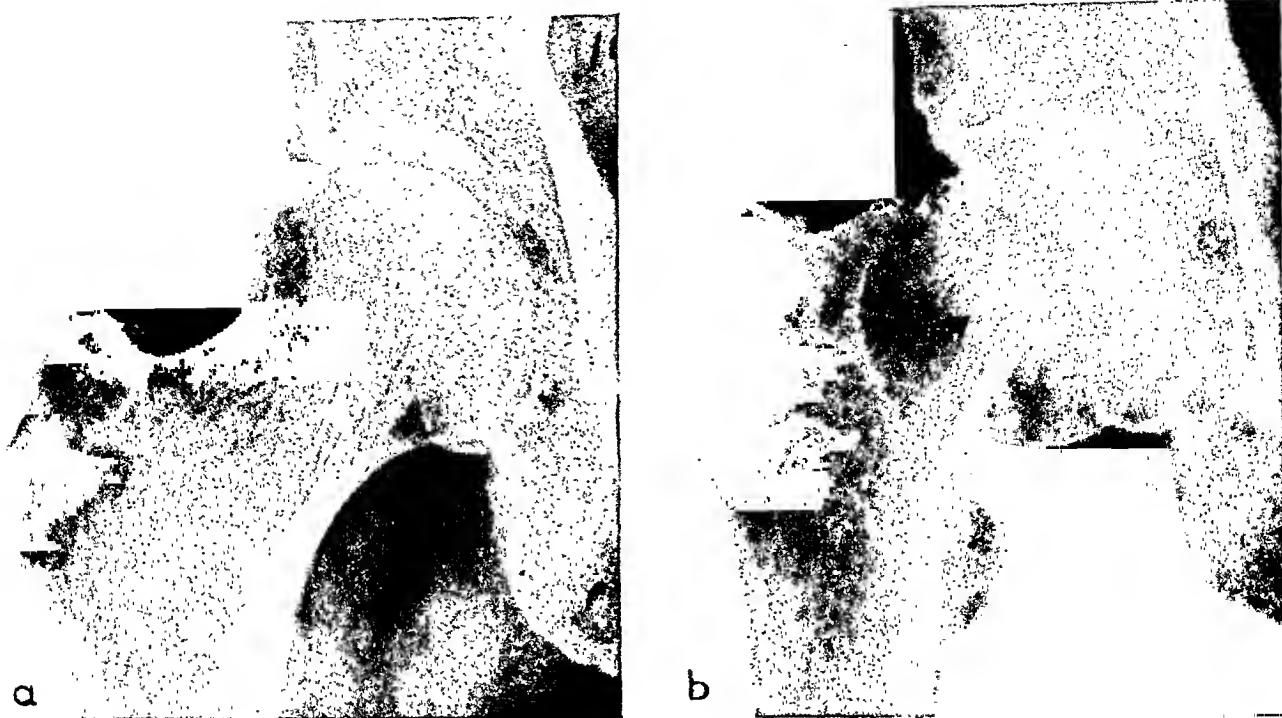


FIG. 1. Case II. Right hip. *a*, normal right femur, fourteen months after irradiation. The left femur also appeared normal at this time. *b*, fracture of neck of right femur with zone of sclerosis, thirty-three months after irradiation. Note the characteristic zone of sclerosis of neck of femur (arrow) and the moderate displacement.

voltage roentgen rays, followed by 5,000 mg-hr. of radium emanation applied directly. Roentgen examination February 15, 1940, indicated both hips to be normal. In Figure 1*a* is illustrated the roentgenogram of the right hip at that time. The left was similar.

In April, 1941, two and half years after the therapy, the patient noticed pain in her right hip without preceding injury. Examination July 23, 1941, demonstrated a fracture of the right femoral neck (Fig. 1*b*) and sclerosis with a partial fracture of the left femoral neck (Fig.

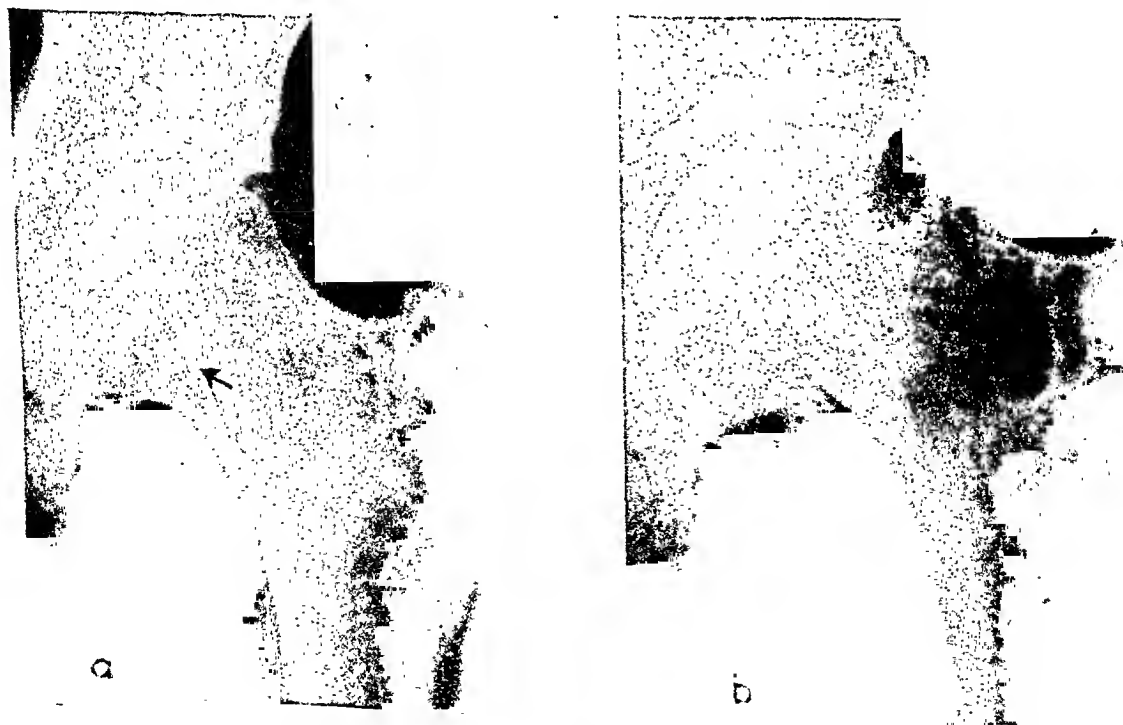


FIG. 2. Case II. Left hip. *a*, zone of sclerosis and beginning fracture line (arrow) visible thirty-three months after radiation therapy. *b*, complete fracture of neck of left femur three months after roentgenogram shown in *a*.

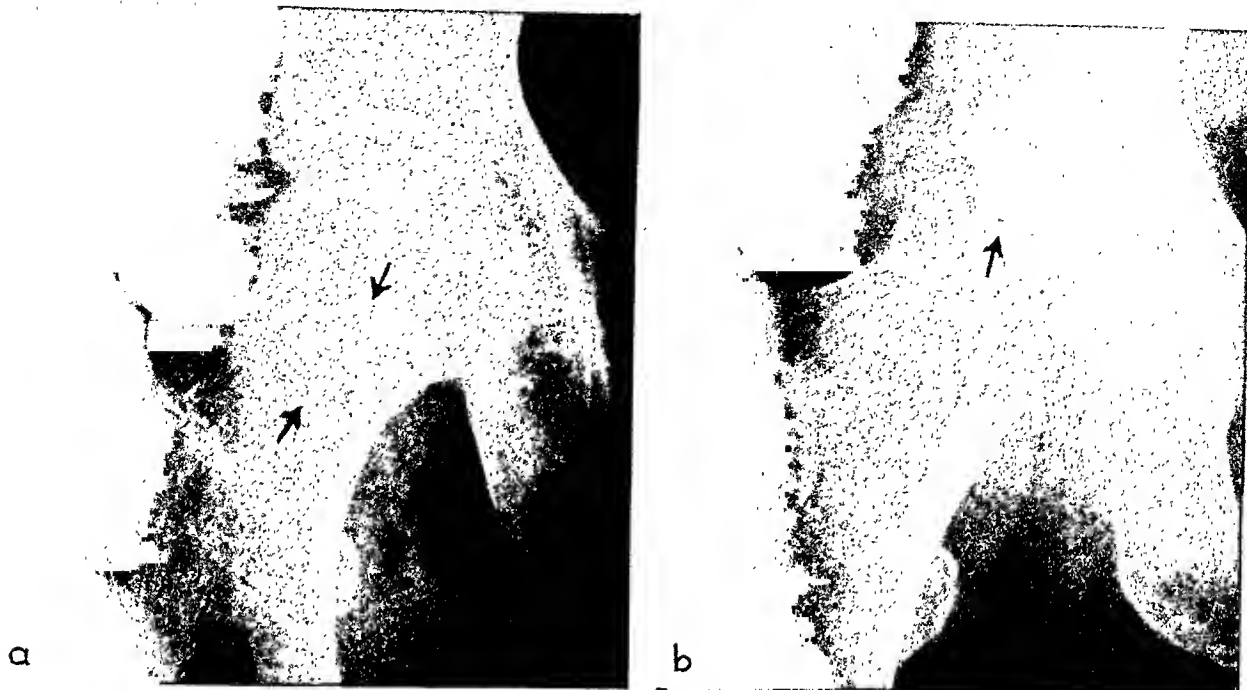


FIG. 3. Cases III and IV. *a*, Case III. Sclerosis of neck of femur appearing five months after last irradiation. Note the zone of rarefaction just distal (lower arrow) to the zone of sclerosis (upper arrow). The hip was cared for at once, and a complete fracture did not develop. *b*, Case IV. Aseptic necrosis of femoral head appearing twelve months after irradiation. Note the complete defect in the head (arrow) and some sclerosis bordering it.

2a). In August, 1941, a McMurray osteotomy was performed on the right side. On October 9, 1941, while turning in bed, she sustained a complete fracture of the left femoral neck (Fig. 2b) and a McMurray osteotomy was performed on that side. In December, 1942, the patient was able to be around the hospital ward with a mechanical aid.

*Comment.* This is a typical example of a bilateral irradiation injury. The opportunity for examination of the left hip before a fracture occurred was afforded here. The symptoms referable to the left hip were minimal, but the roentgen evidences of impending fracture as shown by the sclerosis and rarefaction were perfectly clear. The difference in the time of appearance of the bone changes on the two sides is notable.

CASE III. L. B., aged sixty-five, was found to have a squamous cell carcinoma of the uterine cervix in March, 1941. Roentgen therapy was administered, with a tumor dose of 2,780 r, followed by 4,500 mg-hr. of radium emanation applied directly to the cervix.

A roentgenogram of the pelvis was made at the beginning of treatment, March 4, 1941, and

the femora appeared normal. In July, four months after the last treatment, she developed pain in the right hip and difficulty in walking. There was no history of injury. Roentgen examination one month later (Fig. 3a) revealed a zone of sclerosis and an area of rarefaction in the femoral neck. Restriction of motion was enjoined upon her, but no other therapy was administered. On March 11, 1942, another roentgen examination showed an increase in the process. Her symptoms had diminished, and a complete fracture did not develop. The pain later disappeared completely.

*Comment.* The rapidity of development of symptoms (four months) and roentgen signs (five months) is notable. The characteristic zone of sclerosis and necrosis was clearly made out. It is remarkable that it did not progress further. In many instances such a zone of sclerosis can be observed prior to the actual occurrence of a fracture. It may be possible that a slight trauma will precipitate the completion of the process.

CASE IV. R. H., aged seventy-two, in March, 1940, was found to have a squamous cell carcinoma of the cervical stump. A series of deep

roentgen treatments was administered, with a tumor dose of 2,870 r. This was followed by 4,000 mg-hr. of radium emanation.

In May, 1941, one year after the therapy, the patient complained of pain in her right hip and

*Comment.* The defect in the femoral head is striking. No sclerosis was seen, probably because roentgen examination was not made earlier. It is remarkable that so much change had occurred so quickly after the

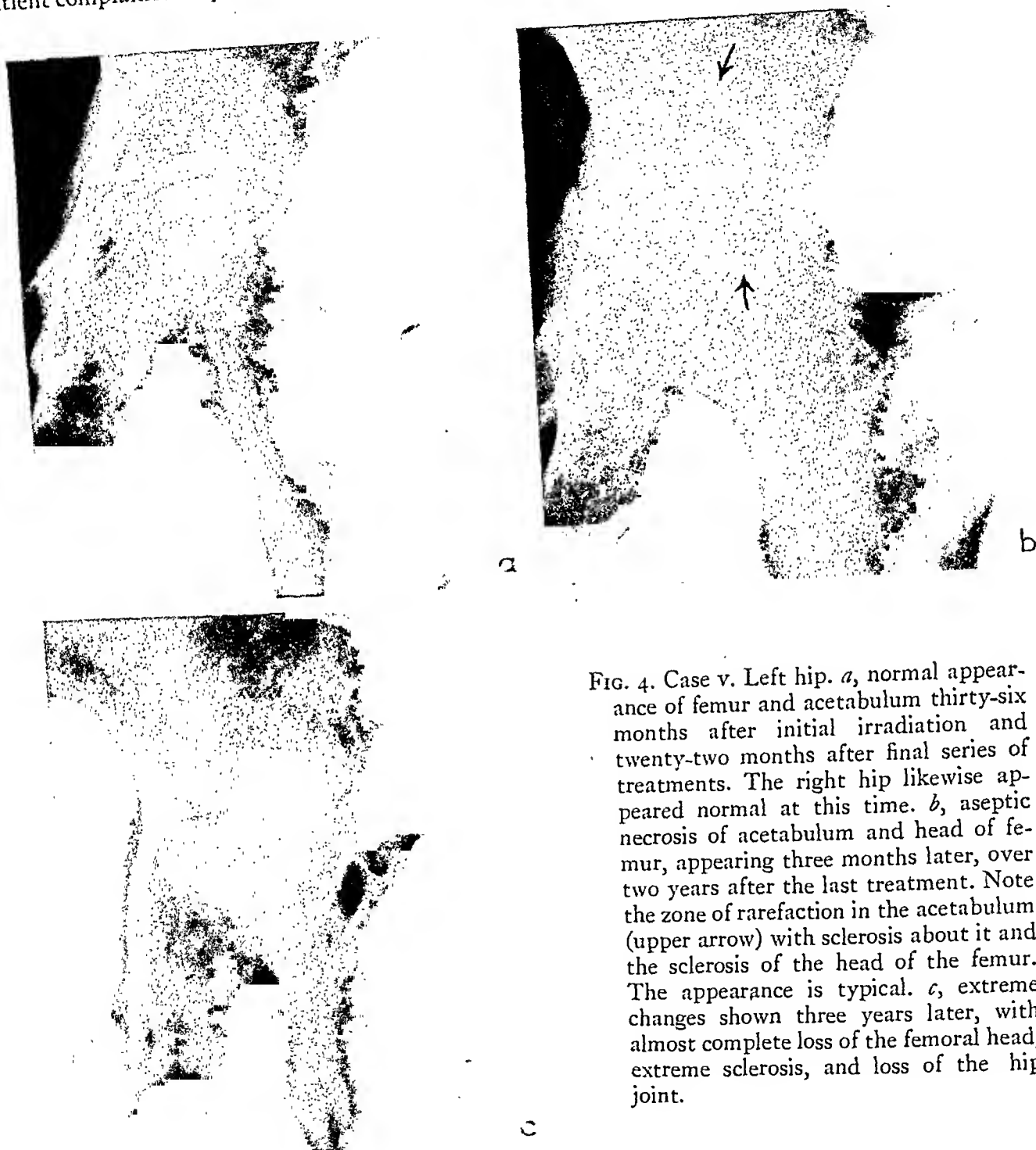


FIG. 4. Case v. Left hip. *a*, normal appearance of femur and acetabulum thirty-six months after initial irradiation and twenty-two months after final series of treatments. The right hip likewise appeared normal at this time. *b*, aseptic necrosis of acetabulum and head of femur, appearing three months later, over two years after the last treatment. Note the zone of rarefaction in the acetabulum (upper arrow) with sclerosis about it and the sclerosis of the head of the femur. The appearance is typical. *c*, extreme changes shown three years later, with almost complete loss of the femoral head, extreme sclerosis, and loss of the hip joint.

thigh without preceding injury. A roentgenogram (Fig. 3*b*) revealed aseptic necrosis of the right femoral head. There was a defect on the articular surface but little or no sclerosis. Subsequent examinations revealed no further progress of the necrosis, and the patient had less pain.

onset of symptoms. The appearance indicates that in this case roentgen findings might have been detected prior to the first symptom.

CASE V. A. K., aged sixty-one, was admitted in November, 1936, when a squamous cell car-



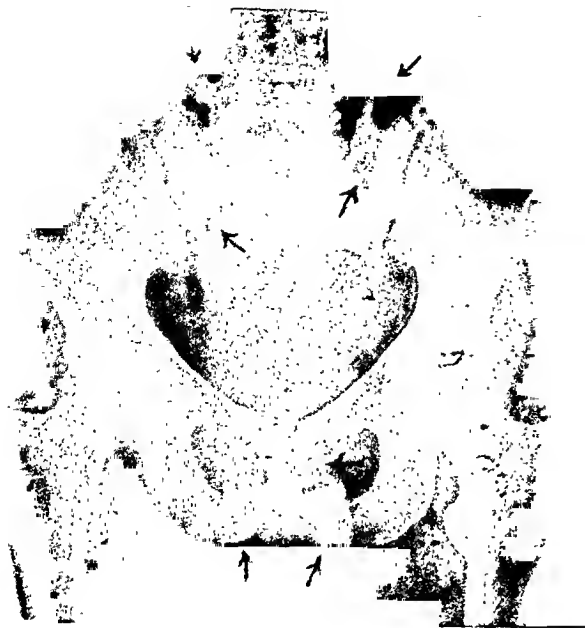


FIG. 8. Case VII. Multiple fractures and necrosis of the pelvic bones following irradiation. Note the marked disorganization of the pubic rami, large areas of defect, fractures of the transverse processes of the fifth lumbar vertebra and of the sacrum with some sclerosis about them (multiple arrows). These findings appeared approximately nine months after irradiation without preceding trauma. There has been a gradual but definite repair.

tional irradiation was sufficient to produce a spontaneous fracture of the femoral neck. It would appear that even trauma will not necessarily produce a fracture of the femoral neck if the conditions following irradiation are not conducive to it.

CASE VII. T. L., aged fifty-five, was found to have a squamous cell carcinoma of the cervix uteri in April, 1941. She was treated with high voltage-roentgen rays, yielding a calculated tumor dose of 2,180 r over a period of twenty-three days. Radium emanation of 3,500 mg-hr. was given by direct application two weeks later.

In February, 1942, eight months after completion of the radiation therapy, the patient complained of pain in her pelvis. There had been no injury. Roentgenograms revealed multiple, rather destructive fractures of the pubic rami, the sacrum, and the transverse processes of the fifth lumbar vertebra. The amount of pain and disability was astonishingly small considering the extent of the process. In August, 1942, re-examination (Fig. 8) revealed much the same findings except that there was some tendency toward repair and some increased dis-

placement of the fragments. By December the patient was fully ambulatory but still had some pain. Two years later she was apparently well and had no complaints.

*Comment.* The close resemblance to Case VI is striking. In this patient there was no injury. As in Case VI the fractures were atypical, and the displacement of some of the fragments was rather marked. There is increased density of the sacrum suggesting some sclerosis here as well. While the whole appearance is unusual, the absence of injury, the relatively minor symptoms, and the appearance of the changes eight months after irradiation all indicate clearly that these bone lesions were due to the radiation therapy.

CASE VIII. T. T., aged fifty-one, presented herself September 19, 1939, and was found to have an adenocarcinoma of the cervix in Stage III. She was treated with roentgen rays in November, 2,500 r being applied to the tumor over a twenty-five day period. This was followed by direct application of 5,000 mg-hr. of radium emanation. In November, 1940, a nodule was found in the vagina and this was again treated by direct application of radium. In March, 1941, she complained of "rheumatism" in her right leg, but this was transient

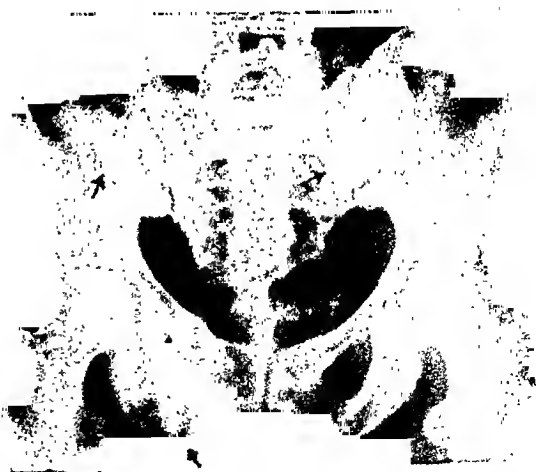


FIG. 9. Case VIII. Fractures and aseptic necrosis of pelvic bones following irradiation. Note fractures of rami of right pubic bone and area of necrosis of left pubic bone. Note areas of sclerosis about the right sacroiliac joint and also to a lesser degree around the left. These findings all appeared without apparent trauma thirty-two months after irradiation.

and disappeared within a month. There was no history of injury other than an accident eight years before which resulted only in some facial bruises. In June, 1942, a routine roentgenogram (Fig. 9) of the pelvis was made and revealed healing fractures of the rami of the right pubic bone, rarefaction of the body of the left pubis, and sclerosis of the right ilium alongside the sacroiliac joint. There were no complaints at this time. Six months later, in December, 1942, she slipped on the ice and sat down hard. Following this she had pain in her back but there was no disability. In April, 1944, she complained of pain about both sacroiliac joints, more especially the left. Roentgen examination at this time showed the fractures to be completely united, the sclerosis about the right sacroiliac joint to be increased, and some sclerosis about the left sacroiliac joint.

*Comment.* The character of the fractures of the pubic rami occurring without preceding injury and the relative absence of symptoms are characteristic of irradiation effects. The sclerosis about the sacroiliac joints differs sharply in its appearance from benign osteitis and is best explained on the basis of an irradiation effect.

#### DISCUSSION

It is evident from the cases here presented that irradiation may affect all the bones of the pelvis as well as the neck of the femur. Furthermore, the effects may be multiform, including fractures, sclerosis, osteoporosis, and aseptic necrosis of the femoral head. The symptoms produced were variable but in general were less severe than would be expected from the roentgen appearance. In general, the prognosis of such injuries is fairly good, remarkably good recoveries occurring in many instances with relatively little disability.

#### SUMMARY AND CONCLUSIONS

1. A case of retardation of bone growth resulting from irradiation of the soft tissues during infancy is reported.
2. In a series of 1,363 patients irradiated for malignant conditions of the genitalia, 25 instances of bone changes in the pelvis or femora, occurring in 19 patients were en-

countered. In a series of 568 cases in which routine roentgen examinations of the pelvis were made, 3.2 per cent of the cases developed bone sequelae.

3. In 541 male patients treated for carcinoma of the bladder or prostate no bone sequelae were encountered.

4. Particular attention is directed to the occurrence of aseptic necrosis of the head and neck of the femur and the acetabulum, which occurred in eight instances.

5. There were fourteen cases of fracture of the femoral neck in this series.

6. Three unusual cases with multiple fractures and sclerosis of the bones of the pelvic girdle are reported in detail.

7. The bone changes seemed to occur more frequently after the introduction of a more intensive type of radiation therapy. Bone changes, however, occurred after moderate doses as well.

8. Roentgenologically demonstrable lesions in the bones appeared as early as five months and as late as sixty-two months following the radiation treatments. In almost all instances some symptoms were apparent before the roentgen findings became visible.

9. Repeated roentgen examination permitted the demonstration of sclerotic and necrotic changes prior to the development of fracture or frank aseptic necrosis.

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# VOLUME DOSAGE IN RADIATION THERAPY\*

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IT IS generally agreed that the biological effect produced by a beam of radiation depends on the quantity of energy absorbed from the beam by the tissue traversed. Attempts to measure this quantity directly by microcalorimeters were made but proved impractical. The introduction of the ionization method of measuring the intensity of a beam of radiation placed dosimetry on a sound basis and made possible a practical international unit—the roentgen. It remained for Gray,<sup>6,7</sup> Mayneord<sup>13</sup> and Haphey<sup>11</sup> to indicate how these ionization measurements may also be utilized to estimate the energy absorbed in tissues, i.e. the volume or integral dose.

The concept of volume dosage will probably contribute considerably to many problems of dosimetry. It has been used by Mayneord<sup>14</sup> as a logical basis for the selection of the optimum quality for roentgen radiation and by Gray and Read<sup>8</sup> for the measurement of the neutron doses in biological experiments. Present methods of calculating volume dosage,<sup>12,13</sup> while still inexact, are sufficiently accurate to warrant general clinical use.<sup>4</sup> In total body irradiation, in problems of protection and whenever deep-seated lesions are treated, it is important to make these calculations in order to anticipate the severity of the constitutional reaction. In the choice of fields for irradiation of deep lesions, the volume dose may play a decisive rôle.<sup>20,21</sup> Mayneord<sup>13</sup> points out that biological effects which depend primarily on total energy absorption may be expected to show a marked wave length dependence since short wave lengths would be much more effective per roentgen on the surface. For purposes of protection, a tolerance volume dose should also be specified and, as Braestrup<sup>1</sup> indicates, the volume dose does not decrease with distance in the same way as

the surface dose. (For example, doubling the target-skin distance may cut the surface dose to one-fourth but the area covered by the beam may be quadrupled.)

The most convenient unit in which to express volume dosage is the “cc.-roentgen.”<sup>3,10</sup> This may be defined as the amount of energy absorbed when a dose of one roentgen is delivered throughout one cubic centimeter of water or of “soft” tissue. The cc.-roentgen is not exactly the same as the gram-roentgen defined by Mayneord<sup>13</sup> as the “energy conversion when a dose of one roentgen is delivered to one gram of air.” Soft tissue and air are, however, so similar in this respect (energy absorption per unit mass) that the difference between these two units may be neglected for practical purposes. The cc.-roentgen may be converted<sup>12</sup> into ergs by multiplying by 109 (or into calories by multiplying by  $2.6 \times 10^{-6}$ ) for roentgen-ray beams. The factor of conversion is, however, not exactly known. This is not important, however, because the procedure of converting cc.-roentgens into ergs actually does not contribute any further information and is superfluous.<sup>13</sup>

The method of calculating volume dosage described by Haphey<sup>12</sup> is relatively simple and has been utilized clinically by Ellis.<sup>4,5</sup> This method involves graphical integration of the depth dose curves for a given quality. The results of this integration for a half-value layer of 1.5 mm. Cu are included in the paper by Ellis.<sup>4</sup>

The method outlined by Haphey was used to calculate the volume dose in cc.-roentgens per square centimeter of any given field per roentgen measured in air. This quantity—the number of cc.-roentgens per sq. cm. per r measured in air—may be arbitrarily designated as  $F$ . The total volume dose is obtained by finding  $F$  for a

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given half-value layer and a given thickness of tissue and then multiplying  $F$  by the area of the field and the dose in  $r_{\text{air}}$ , or

$$\text{Volume dose in cc.-roentgens} = F \times \text{area of field} \times r_{\text{air}}$$

(This method of expression differs from that of Haphey<sup>11,12</sup> and Ellis<sup>4</sup> in that the maximum back-scatter figure is included in  $F$ . Also, the skin dose is replaced by the air

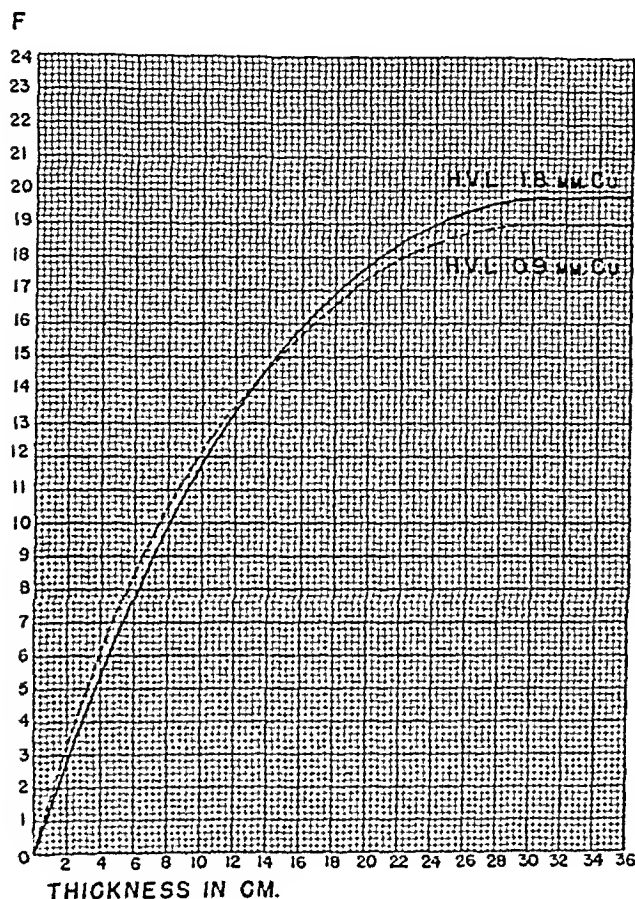


FIG. 1. Graph giving the values of  $F$  for different thicknesses for half-value layer of 0.9 mm. Cu and half-value layer of 1.8 mm. Cu. The volume dosage in cc.-roentgens is obtained by multiplying  $F$  by the area of the field and the dose, in roentgens measured in air, delivered to the field.

dose, thereby eliminating the back-scatter figure for the given field.) The curves of Figure 1 give the values of  $F$  for a half-value layer of 0.9 mm. Cu and a half-value layer of 1.8 mm. Cu. The depth dose and back-scatter figures were kindly furnished by Braestrup<sup>1</sup> and were determined in a full thickness water phantom.

The value of  $F$  (in this approximate method) is the same for all target-skin dis-

tances for which depth doses may be calculated by the inverse square law from the values for a 50 cm. target-skin distance. According to Quimby<sup>16</sup> and Braestrup,<sup>1</sup> this covers at least the range from 50 to 100 cm. (Ellis<sup>4</sup> shows slightly different values for different target-skin distances presumably because he utilized the depth dose figures published by Mayneord which do not quite follow the inverse square law.)

From the curves it is clear that the differences in volume dosage with beams of these two half-value layers are not great. As expected, for small thicknesses, the energy absorption is greater for the lower half-value layer, while for large thicknesses, the reverse is true.

*Example:* 300 r measured in air was delivered to a 15×15 cm. pelvic field; half-value layer, 1.8 mm. Cu. The thickness of tissue irradiated was 20 cm. Find the volume dosage.

From the graph of Figure 1, we find that for a half-value layer of 1.8 mm. Cu and a thickness of tissue 20 cm.,

$$F = 17.8$$

$$\text{Area of field} = 15 \times 15 = 225 \text{ sq. cm.}$$

$$\text{Dose to field} = 300 r_{\text{air}}$$

Substituting these values, we get

$$\text{Volume dose} = 17.8 \times 225 \times 300$$

$$= 1,200,000 \text{ cc.-roentgens}$$

1,000,000 cc.-roentgens equals 1 mega cc.-roentgen.

$$\text{Volume dose} = 1.2 \text{ mega cc.-roentgens.}$$

This figure may be converted to ergs by multiplying by 109.

$$\text{Volume dose} = 1.2 \times 109 = 131 \text{ ergs.}$$

Several sources of error are present in these calculations. The results are therefore only approximate. For example, the "area of the field" should be theoretically not the area of the flat surface but the area of the tangential spherical surface enclosed by the margins of the beam. The difference between these two areas, however, is less than 10 per cent unless the average diameter of the field exceeds one-half of the treatment distance.<sup>11,12</sup> Also, these values of  $F$  should not be applied to fields smaller than about 6×8 cm., to total body irradiation, to very elongated fields or to small thick-

nesses of tissue. (For energy absorption in total body irradiation, see Mayneord.<sup>13,15</sup>)

Upper limits to the number of cc.-roentgens which may safely be given within various time intervals to different parts of the body exist but only a few have been estimated. Smithers<sup>17</sup> states that the maximum safe volume dose to the thorax in forty-two days is about 28 mega cc.-roentgens; to the pelvis in thirty-one days, 36 mega cc.-roentgens; to the pelvis in three days, 6 mega cc.-roentgens. A great deal remains to be done before these dosage levels will be known with certainty under various circumstances.

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# EDITORIAL

## RADIUM THERAPY, ROENTGEN THERAPY AND THE RADIATION THERAPIST

**R**ADIUM, potentially one of the greatest boons to mankind, has through misuse and abuse failed to fulfill the high hopes the medical profession had for it. *Why* and more important *how* can it achieve its rightful place as a leading therapeutic agent for disease?

A car with perfect brakes, new tires and all the other requisites that are included to make it work does not move when the attempt to drive it is made by a person who does not know how, and is a potential danger in the hands of an inexperienced driver. Such is the story of radium.

All radiological societies and the American Medical Association have gone so far as to refuse commercial radium advertising unless rental or sale is restricted to competent radiologists. Notwithstanding this highly laudable attitude, there has been no abandonment of the unrestricted sale of radium and radon to hospitals without the least regard for the ability or competence of those who might use the radium.

The hospitals have been one of the main factors in lowering not only the status of the radiation therapist but also the value of radium as a therapeutic agent. They are in altogether too many cases indiscriminate in regard to those who may use radium. The hospitals have more and more commercialized radiology in spite of the efforts of the few to fight against this trend. This has produced a disregard for experience, learning and training in radium therapeutics.

Equally culpable is the physician who owns or leases a little radium and then makes it available in return for a financial consideration to any colleague who requests it, regardless of the renter's lack of training and inability to use the radium properly.

Skinner<sup>1</sup> in noting the situation states that while he does not decry the rental of radiant energy to qualified radiologists, he most vehemently assails the propriety of its use by any unqualified physician on an unsuspecting and undiscerning public.

If no more is required than that non-radiologically trained surgeons or physicians make verbal requests for the loan of radium under the perfunctory, casual supervision of a hospital radiologist, radium therapy can scarcely achieve successes. The radium therapist must earn and merit the respect due a competent clinician practicing radium therapy. As Friedman<sup>2</sup> states, "The practice of certifying men in 'Radiology,' who have had little or no experience with radium is to be deplored."

Quick<sup>3</sup> says, "No man should attempt roentgen therapy without a thorough working knowledge of radium. Whether he actually handles the radium himself or not, he should know when and how it should be done. There should be no roentgen therapist, he should be a therapeutic radiologist. The need for this distinction and the need for correction of one sided training, as it too often exists today, has been noted many times in the American Board of Radiology."

McWhirter<sup>4</sup> holds that to carry out radiation therapy properly and evaluate its effects, the therapist should be master of both roentgen and radium radiation. Best results are achieved in large centers, where numerous cases of a given type can be gath-

<sup>1</sup> Skinner, E. H. Introduction to the history of carcinoma of the cervix uteri. *Radiology*, 1943, 40, 433-435.

<sup>2</sup> Friedman, M. Personal communication.

<sup>3</sup> Quick, D. *New York State J. Med.*, 1944, 44, 981-985.

<sup>4</sup> McWhirter, R. Some observations in radiotherapy. *Radiography*, 1943, 9, 41-45.

ered and sufficient experience thereby obtained in recognition, diagnosis and therapy. He doubts that small treatment centers can make any useful contributions to the advancement of knowledge in the cancer field and in fact he maintains that their very existence detracts from the larger centers and makes them less effective. Under the National Cancer Act in Great Britain, the Faculty of Radiologists has advanced a plan for radiotherapy, namely that roentgen and radium therapy must be organized as a single department, completely separated from the department of radiodiagnosis. Experience has shown that where this is not in force radiotherapy is of mediocre caliber, and of secondary importance; especially in the matter of radium therapy, the radiologist is relegated to the side lines and every other specialist does the radium therapy he himself should be carrying out by reason of his training and experience and so make the title of Radiation Therapist significant.

Who is, or rather, who should be a radiation therapist and to whom should radium be entrusted? Is he one of the large group of physicians hastily trained by the Army in the rudiments of diagnostic roentgenology and given only sufficient knowledge for emergency treatment of the wounded? Is he the radiologist who despite his inadequate experience in radium therapy regards himself as a therapist merely because therapy is a sideline for which certification is so easily obtainable? Is he the gynecologist or surgeon who though unqualified undertakes to prescribe treatments because of the lowered status of radiotherapy? Is it any member of the medical staff of a hospital who undertakes treatment with radium simply because of its availability? The answer we believe must be an emphatic "no" in all of the above cases.

We must make certain that a radiation therapist has had sufficient experience during his training with the treatment of various forms of the common lesions such as cancer of the cervix, tongue or tonsil. Familiarity with stated principles does not

carry with it knowledge of specific radiotherapeutic implications unless it has been accompanied by participation in the examination and treatment of a large number of cases. For example, it requires experience to differentiate between a papillary and a diffusely infiltrating cancer of the tongue; to perform a vaginal examination and describe the findings; to differentiate between an infiltrating or a non-infiltrating cancer of the lip or skin. What should be the background of the radiation therapist and what should be his position in the medical field?

A certain awareness of the all embracing medical knowledge required by the radiation therapist has existed as evidenced by Skinner's<sup>5</sup> statement in 1933. "I look upon radiology," he said, "as a service department in diagnostics and as an autonomous field in therapy. . . . Roentgen diagnosis, while venturing deep into clinical diagnosis does not carry the essential responsibilities that radiotherapy forces upon the radiologist. . . . The field of radiologic therapeutics, both roentgen and radium therapy, carries a dignity and responsibility that cannot be assailed or absorbed by technician or tyro. The ultimate results of radiologic therapy depend upon the painstaking, thoughtful application of physical and optical laws of radiant energy based upon judgement, backed by experience and warranted by cooperative authority."

What should be the status of the radiotherapist? The position is distinctly a clinical one in medicine and equal to that of the surgeon. In fact, one with good surgical training and experience makes a better radium therapist. The present method, therefore, of certifying radiation therapists does not presuppose a properly trained clinician. There is no substitute for experience and not until certification is based on clinical experience can any examination properly qualify the radium therapist. The radiologist who regards radiation therapeutic practice merely as a sideline to roentgenology may fail to give his patient

<sup>5</sup> Skinner, E. H. Relation of radiology to other fields of medicine. *Colorado Med.*, 1933, 29, 179-181.

adequate and proper treatment. Actual and potential dangers are likely to appear even when treatment is carried out by the best trained radium therapist. How much more so is the danger aggravated at the hands of the novice equipped only with book-learning, didactic lectures and inadequate observation. Only when the radiation therapist is thoroughly qualified through training and experience to practice radium therapy will progress have been achieved in the interest of the patient under his care.

If just as we entrust the scalpel only to the hands of the surgeon so we entrust radium only to the hands of the radiation

therapist, then and then only will radium fulfill all of its promises and the radiation therapist assume his rightful position among those recognized as specialists.

When radiologists as well as physicians realize the importance of radiation therapy as a specialty and demand high standards for those who practice it then will the radiation therapist receive the respect due him and produce the results in service to the patient that only he is potentially capable of giving.

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*Items for this section solicited promptly after the events to which they refer.*

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*Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago.*

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*Secretary, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.*

#### RADIOLOGICAL SOCIETY OF NORTH AMERICA

*Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: 1945, to be announced.*

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#### SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

*Secretary, Dr. Earl R. Miller, University of California Hospital, San Francisco, Calif.*

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*Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.*

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#### NORTH CAROLINA ROENTGEN RAY SOCIETY

*Secretary, Dr. Major Fleming, Rocky Mount, N. C. As-*

\* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

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Mid-year scientific meeting at place designated.
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- SAN FRANCISCO RADIOLOGICAL SOCIETY**  
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**BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY**

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The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

## COMMITTEES OF THE AMERICAN ROENTGEN RAY SOCIETY

**I**N ADDITION to the committees of the American Roentgen Ray Society which are carried regularly in the JOURNAL, the following committees have been appointed for 1944-1945:

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## DEPARTMENT OF TECHNIQUE

*Department Editor:* ROBERT B. TAFT, M.D., B.S., M.A., 103 Rutledge Ave.  
Charleston, S. C.

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### DEVICE FOR PREVENTION OF ACCIDENTAL RADIATION OVERDOSAGE DUE TO INCORRECT FILTER-KILOVOLTAGE COMBINATIONS

By M. F. HALL, M.D.

JOPLIN, MISSOURI

ROENTGEN therapy dosage has become so universally controlled by the use of the r-meter, and the tissue tolerance so well established by experience and experimentation, that there is little likelihood of serious overdosage occurring when treatment is administered directly by qualified radiologists using modern equipment. The intended dosage infrequently results in serious damage to normal tissue.

On the other hand, very little progress has been made toward the prevention of accidental overdosage, and each year many such accidents occur. Fortunately, many of the overdosages do not produce serious results. The great majority of overdosages have been due to improper filter-kilovoltage combinations and most radiologists have directly or indirectly had experience with some degree of accidental overdosage.

During the present National Emergency every radiologist has to take care of a larger number of patients, with less technical assistance. In some instances the technical assistants are untrained and inexperienced. These conditions increase the hazard of accidental overdosage and place a greater responsibility upon the radiation therapist.

The greatest danger of accidental overdosage is associated with the use of roentgen therapy machines which may be used with little or no filtration and medium or high kilovoltage.

When applied to machines used for both superficial and deep therapy the device to be described and illustrated positively pre-

vents therapy without filtration when the kilovoltage is higher than that desired for therapy without filter. The selection of kilovoltage for the various filters to be used is done prior to installation. Changes in kilovoltage to be used with any one of the filters can be made later by changing wires leading to the filter selector. If the incoming line current is remarkably unstable it is desirable to have a line voltage compensator such as those used on all roentgenographic machines and some therapy machines. The filter must be correct for the kilovoltage, and vice versa. The timer and roentgen-ray switch will not operate until the filter and kilovoltage are matched.

The greatest possible error to be made while using a machine equipped with such a safety device would be in overlooking both the filtration and kilovoltage. Following a superficial therapy treatment, the therapist could prepare a patient for medium or deep therapy, and in failing to change either the filter or kilovoltage could administer treatment at low kilovoltage without filter for the time intended to give the treatment at higher kilovoltage with heavier filtration. Even conceding this gross double error, the overdosage would amount to only one-fifth to one-tenth that which would occur were it possible to treat at high kilovoltage and no filter for the same length of time.

The device can be installed on any type of roentgen therapy equipment and used as a protection against incorrect filtration-



kilovoltage combinations. Deep roentgen therapy machines can be equipped as well as those used for superficial therapy. The timer is included in the circuit. Otherwise the timer might be turned on without closing the roentgen-ray switch and should the timer automatically release before the therapist or technician noted the open switch, he would not be aware that the patient had not received treatment.

The device should be easily adapted to machines using turret type filter head. When both deep and superficial roentgen therapy machines are used in the same department or office, the deep therapy machine may be allowed a relatively heavy minimum filtration, more filtration being added as desired. The portals having filtration of less than 0.5 mm. Cu plus 1 mm. Al can best be eliminated or changed to heavy-

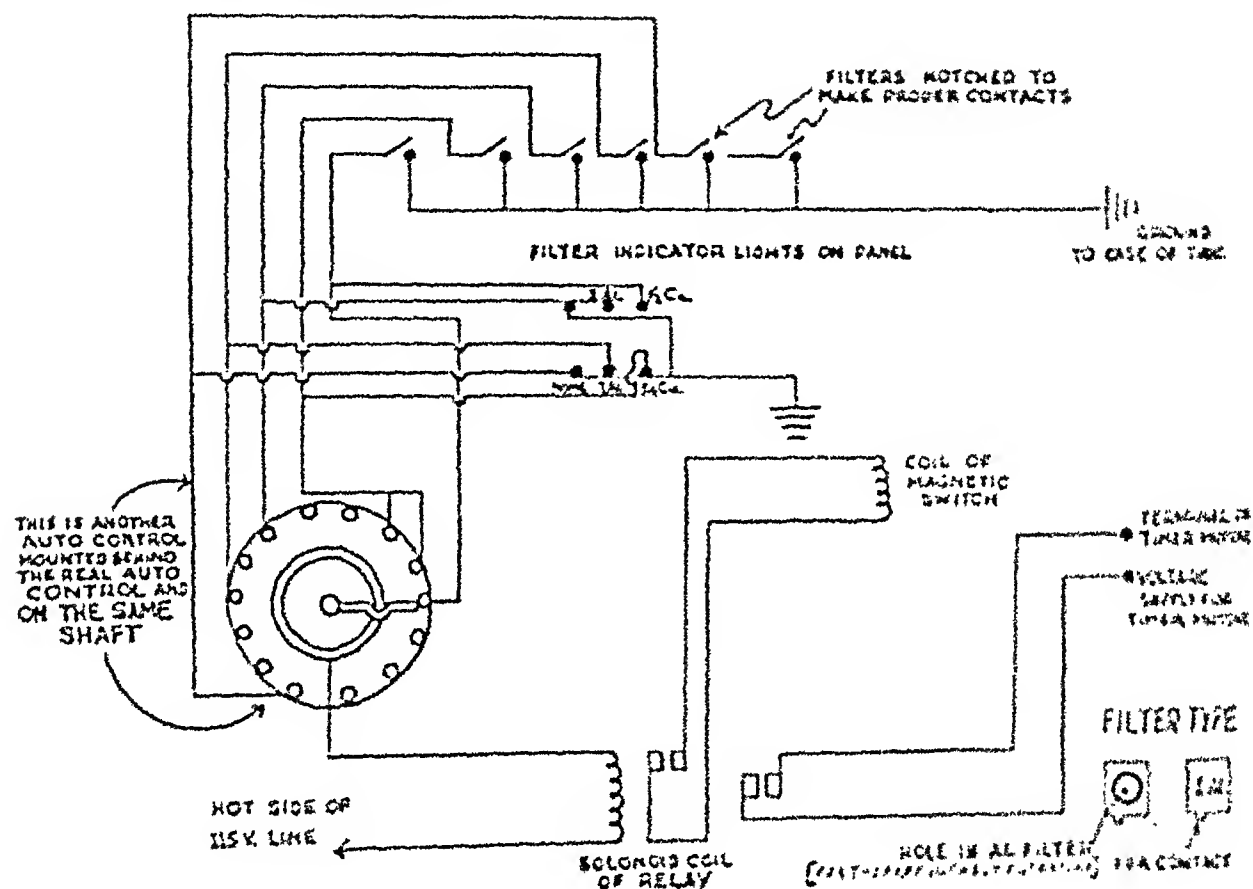


FIG. 1

The device is relatively inexpensive but requires moderate skill in fitting the contact arms to the tube casing so they will accurately and permanently make contact with contact tongues on the filter. Failure to make contact would not be dangerous since any contact failure prevents operation of the machine. The filter is cut away on one side and a stop placed on the tube head preventing contact should the filter be inserted wrong side up. The same stop and cut away combination are utilized to produce proper function of the contact arm against the contact tongues on the filter.

For filter filtration. If the machine has a turret type filter head, this is easily done by changing the ports containing aluminum filtration with lead. When this change is made the deep roentgen therapy machine will give relatively safe output without the safety device. The output using 0.5 mm. Cu plus 1 mm. Al is not much greater than that obtained with Cu plus 1 mm. Al plus 1 mm. Al. The change is a little more difficult to make than the change in the output of a deep therapy machine from 0.5 mm. Cu plus 1 mm. Al to 0.5 mm. Cu plus 1 mm. Al plus 1 mm. Al.

Since each filter must have its own kilovoltage, and therapists often use the same kilovoltage with different filters, the circuits may be so arranged that two or more filters are matched to kilovoltages only one step apart, the heavier filter being used with the higher kilovoltage. Thus 0.5 mm. Cu plus 1 mm. Al may be used with 140 kv. and 0.25 mm. Cu plus 1 mm. Al with 135 or 138 kv.

Should the radiation therapist desire to administer a large dosage within a very short time by using high kilovoltage without filter, he could have a master contactor constructed similar to that used in treating without filter at low kilovoltage. This, however, is inadvisable since it introduces a definite hazard. The occasional loss of a few minutes when using a potentially lethal machine is a small price to pay for safety.

The removable combination filters should be riveted together for obvious reasons. As an added safety measure the filter-indicator pilot lights should be placed at eye level to readily attract the operator's attention. Be-

low each pilot light a small drawer index frame may be attached to hold a card giving the r-output at various distances for the filtration indicated.

It has been found after several months' use that the device does not in any way interfere with applying the roentgen-ray beam to the treatment area and has, to date, required no electrical or mechanical service.

#### SUMMARY

A safety device for use on roentgen therapy machines has been described and illustrated. It will positively prevent administration of treatment at higher kilovoltages without proper filtration. It is intended and believed to be an absolute protection for the patient against accidental overdose due to incorrect filter-kilovoltage combinations. In using it, the radiologist finds his work easier and fraught with less apprehension.\*

622 Frisco Building  
Joplin, Missouri

\* The cooperation of the General Electric Company in helping to install the device is acknowledged.



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# ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

## ROENTGEN DIAGNOSIS

### NECK AND CHEST

GARTSIDE, V. O. B. Agenesis of the lung. *Brit. J. Radiol.*, March, 1943, 16, 69-71.

A child seven years of age was first sent for examination at the age of five because of a swelling of the neck. When sent for examination this time he had no serious illness but the mother reported that he easily got cold on the chest. Roentgen examination showed the left bronchus only about half its normal length. It tapered abruptly and ended in a small bronchus that had many slender twigs supplying a wedge-shaped segment of normal lung tissue that lay immediately above the dome of the diaphragm. The fine bronchi in this area seemed to be normal.

Thirty-four cases of agenesis of the lung had been described up to 1937. The children affected generally die of asphyxia at birth. The condition is frequently associated with other abnormalities and in the case described above there were spina bifida, wedge-shaped vertebrae, cervical ribs, fusion of ribs, congenital high scapula and a congenital heart lesion, probably a defect of the septum.

The condition is probably due to some developmental defect in the germ-plasm.—*Audrey G. Morgan.*

EVANS, WILLIAM A., JR. Echinococcus cyst of the lung. *Radiology*, April, 1943, 40, 362-366.

Echinococcus disease is rare in North America but very prevalent in Australia, Iceland, North Africa and South America. Under war conditions, therefore, it would be well for American physicians to be thoroughly grounded in the roentgen signs of the disease.

A case in an Italian boy twelve years of age is described and illustrated with roentgenograms. The boy had lived in Italy for seven years. He had pain in the left chest and a non-productive cough. He had had a similar attack a year before. Roentgen examination March 16, 1942, showed a sharply circumscribed shadow of uniform density except for a capsule at the periphery with a layer of air between the cap-

sule and the mass. A presumptive diagnosis of benign tumor was made. On re-examination a week later after a diagnostic pneumothorax the air beneath the capsule was no longer seen. On operation April 4, 1942, a hydatid cyst was removed. Recovery was uneventful.

This finding of air between the parasite and the adventitia is a pathognomonic sign at a certain stage of echinococcus cyst of the lung. A diagram is given of the appearance in the different stages of development of the cyst. In stage 1 there is a rounded shadow of uniform density which cannot be differentiated from that of tumor. In stage 2 air has entered the space between the adventitia and the hydatid vesicle, giving the pathognomonic picture seen in the above case. In stage 3 there has been further separation of the cyst and adventitia and disintegration of the cyst has allowed the cyst fluid to leak into the pericystic space. This is called Cumbo's sign or the double arc sign of Ivanissevich. In stage 4 the cyst has collapsed completely and the retained membrane floats on the cystic fluid giving the water-lily sign of Segers and Lagos Garcia.—*Audrey G. Morgan.*

RIGLER, LEO G. The infected lung cyst. *Radiology*, May, 1943, 40, 485-496.

Cysts of the lung are not uncommon and their correct diagnosis has become increasingly important since developments in surgery have made it possible to cure them permanently. As the true lung cyst develops from a bronchial bud it is commonly lined with epithelium. This makes it possible to make a diagnosis by biopsy on draining the cavity. The demonstration of bronchial epithelium makes differentiation from abscess or encapsulated empyema possible. If a supposed empyema fails to clear up on drainage it also indicates cyst of the lung. These cysts, of course, may readily become infected through a communication with the bronchus.

Five cases which illustrate different phases of the problem of lung cysts are described and illustrated with photographs and roentgenograms. The first is a case of the development of a bronchial fistula in a cyst filled with fluid.

The second is one of multiple infected cysts of the lung which simulated loculated empyema or lung abscess. The third was a single large cyst of the lung which had been mistakenly diagnosed as encapsulated empyema but repeated rib resections with drainage had failed to cure the patient. The fourth was one of congenital gas-filled cysts of the lung which later in life had become infected and developed into pockets containing pus which simulated lung abscesses. The fifth was a case of single infected cyst of the lung which had been diagnosed as encapsulated empyema but which had failed to clear up after several rib resections. The correct diagnosis was made by roentgen examination and confirmed by biopsy.

The most important roentgen signs of infected cyst are the sharply encapsulated, well defined pocket standing out separately from the remainder of the chest, the absence of associated pleural thickening, the frequently very low position of the pocket, the absence of any retraction of the mediastinum or diaphragm toward the encapsulated pocket, and the demonstration of a relatively thin wall when air replaces the fluid in the pocket; also the demonstration of trabeculae inside the cyst representing strands of lung tissue.

Such cysts can be permanently cured by radical surgery, preferably lobectomy of the lobe containing the cyst.—*Audrey G. Morgan.*

BELL, E. T., RIGLER, LEO G., SPINK, WESLEY, and Watson, C. J. [Carcinoma of right lower lobe bronchus with metastasis to apex of right lower lobe and extension into mediastinum.] *Radiology*, June, 1943, 40, 594-598.

At this conference a case was discussed which shows the difficulty encountered in the early diagnosis of bronchogenic carcinoma. The patient was a man of sixty admitted to the hospital July 9, 1942, after a study in the outpatient department two weeks before. He complained of weakness, anorexia, loss of weight and dry cough, all beginning in March. His sputum had become purulent and his breath bad but there was no hemoptysis. He had marked clubbing of the fingers, no cyanosis. Atypical acid-fast bacilli were found in the sputum and stomach washings. The roentgen examination indicated peripheral carcinoma, primary in the apex of the right lower lobe with metastasis to the peribronchial lymph nodes at the right hilum and infiltration about the lower lobe bronchus. The patient improved

on rest in bed and that, together with the finding of acid-fast bacilli, suggested tuberculosis and made it necessary to wait for the results of guinea pig inoculation. Biopsy also failed to show positive evidence of tumor.

The patient died on September 20 and the autopsy confirmed the roentgen findings. There was a primary ulcerating adenocarcinoma of the right lower lobe bronchus extending to the surrounding lung and up to the carina and a metastasis in the apex of the lower lobe. It was so extensive that pneumonectomy would have been impossible, but in similar cases the evidence of tuberculosis may cause fatal delay in operation.—*Audrey G. Morgan.*

RHOADS, PAUL S. The probable incidence and clinical features of "virus" pneumonia. *Radiology*, April, 1943, 40, 327-338.

Cases of atypical primary bronchopneumonia have increased greatly in the United States in the past two years. They probably outnumber cases of pneumococcus pneumonia about 4 to 1. It is impossible for the general practitioner to demonstrate virus in these cases so it is probably better to give them the above name, though there is experimental evidence of their causation by virus. Lacking laboratory confirmation, however, the general practitioner must diagnose them from the physical signs. Among these are the scanty physical signs and the mildness of the disease as compared with pneumococcus pneumonia.

The author studied 31 cases observed between August, 1941, and December, 1942. Case reports and roentgenograms of 7 of the cases are given. The comparative mildness of the clinical symptoms is shown by the fact that the average time before the patients reported for treatment was 5.92 days. In these cases the average leukocyte count was 10,600 and the average duration of fever 16.2 days as compared with an average leukocyte count in the pneumococcus cases studied during the same period of 20,300 and an average duration of fever after the beginning of treatment of 5.1 days. The pulse, as a rule, was low as compared with the fever. The temperature range was usually 102° to 104° F. for the first ten days with a gradual fall by lysis. In severe cases with moisture the pulse was usually high. Oxygen was used on all of the patients who had "wet" lungs or cyanosis from any cause. Usually roentgen examination was required to demonstrate consolidation in the beginning as the physical signs were slight

for the first week. The sulfonamide drugs have no effect in this disease. The only serious complication seen in the author's cases was pleurisy with effusion in 2 cases.

Secondary infection is important and the author thinks will become increasingly so as the epidemic advances. In his 1 fatal case secondary infection with *Streptococcus viridans* evidently contributed to the patient's death. A careful study should be made of the bacterial flora of the sputum, nose and throat in order that autogenous vaccines may be made. The use of convalescent whole blood or serum will probably prove useful.—*Audrey G. Morgan.*

SAPHIR, OTTO. Pathological changes in so-called atypical pneumonia. *Radiology*, April, 1943, 40, 339-343.

The atypical or virus pneumonia so prevalent at the present time differs quite markedly from pneumococcus pneumonia. Clinically, it is relatively benign and specific pneumococci or other organisms that might have caused it cannot be demonstrated. Roentgenologically lesions appear rapidly in various lung fields and disappear quickly. The interstitial nature of the disease was first demonstrated by roentgenologists who called it acute pneumonitis.

The author describes 2 cases that came to autopsy and illustrates them with photomicrographs of the findings. Virus studies were not made so it is impossible to say definitely that they were cases of virus pneumonia, but it seems probable. Virus studies are very difficult for not only must a virus be demonstrated but it must be proved that the disease is caused by the virus and not by any associated bacteria, and in animal studies it must be proved that the disease is caused by the human virus and not by one indigenous to the laboratory animal.

Interstitial pneumonia has long been known to occur in association with infectious diseases caused by viruses, such as measles, and it is probable that the initial stage in the influenza epidemic of 1917-1918, which is now thought to have been caused by a virus, was an interstitial pneumonia. The interstitial changes, together with the enlargement of lymph nodes, give rise to dyspnea and cyanosis which are characteristic of severe cases of the disease. The interstitial changes may spread and involve the alveoli. A characteristic feature is the hyalin-like ring that forms the inner lining of many alveoli. The exudate differs from that of lobar or bronchopneumonia in being made up

mostly of mononuclear cells. The usual varieties of virus pneumonia now seen are not very severe and therefore autopsy material is not abundant; therefore the importance of describing the author's 2 autopsy cases even though virus studies had not been made. He concludes that the causative agent was a rickettsial body or virus.—*Audrey G. Morgan.*

McCARTHY, PAUL B. Primary atypical pneumonia of unknown etiology. *Radiology*, April, 1943, 40, 344-346.

The author has seen 590 cases of this condition and considers it a disease entity. The mortality is low. In only 1 of his cases did autopsy show atypical pneumonia to have been the primary cause of death. The patients as a group have not been very sick, though a few have been as ill as with a severe pneumonia. He has found that keeping the patient in the hospital till the chest roentgenogram is relatively clear decreases the chance of recurrence.

Evidence of the disease appears on chest roentgenograms about the fourth day. The findings vary and the cases have been divided into four groups. In the first and largest group the first signs are an increase in the size of the hilar shadow and a generalized increased prominence of the lung markings. There is definite evidence of pneumonic density of one or more lobes which has apparently spread from the hilar region. The density is less than that of lobar pneumonia. In group 2 there is a patchy involvement, usually of only one lobe, suggestive of bronchopneumonia. There is very rapid resolution in this type. In the third group there is extending infiltration radiating from the hilar region and later involving a whole lobe. This type is almost indistinguishable from tuberculosis. In group 4 there are increased lung markings throughout with small parenchymal areas of infiltration somewhat resembling military tuberculosis. The patients in this group are very sick and the course of the disease is long. The distinction between an atypical pneumonia of the upper chest and tuberculosis is difficult.

Four cases, one from each of the four groups, are described and illustrated with roentgenograms.—*Audrey G. Morgan.*

CURTZWILER, F. C., and MOORE, B. E. Primary atypical pneumonia of unknown etiology. *Radiology*, April, 1943, 40, 347-350.

The authors came into contact with this disease at Camp Davis, North Carolina, when

they interpreted minimal changes in one of the upper lobes near the periphery as tuberculosis and found that they cleared up in a few days. On further study they came to recognize the clinical and roentgen findings of primary atypical pneumonia, and state the conclusions they have reached from an examination of over 100 cases. They believe that both clinical and roentgen examination is necessary for diagnosis. The chief symptoms are general malaise, weakness, non-productive cough, fever and general aching. Early in the disease there are no physical findings, later there are coarse râles over the whole chest. The white cell count is normal in the beginning and later may rise to 14,000 to 15,000. Leukopenia has not been seen. The disease does not respond to chemotherapy. The laboratory findings are helpful only in a negative way. The few bacteria found have not been thought to be the cause of the disease. The pulse is relatively low. The temperature may reach 104° F., while the pulse rate has been 90 to 100 per minute.

They believe attention has been called to this disease recently by the mass examinations of the chest for tuberculosis. The roentgenogram most frequently shows a thickening of one or both hilar shadows and a patchy type of peribronchial increased density along the basilar branches of one of the lower lobe bronchi. The patches may become confluent, occasionally to such an extent that it looks like lobar pneumonia. There may be thickening of the pleura over the involved lobe, causing a shadow resembling lobar pneumonia, but this disease can be ruled out by the clinical findings and the white blood count. Examination during resolution again shows a peribronchial type of patchy infiltration. In the central type a lateral projection often shows lesions along the bronchus dorsalis which supplies the apex of the lower lobe. But when this bronchus is involved the patches generally become confluent.

The authors give a warning against interpreting this disease as tuberculosis in the interpretation of survey roentgenograms.

The patients are generally incapacitated for two to three weeks. If discharged too early there is apt to be recurrence. No serious sequelae or complications have been seen. Treatment is symptomatic.—*Audrey G. Morgan.*

HUTCHINS, C. E., and APPLEBAUM, A. A. Atypical pneumonia of probable virus origin. *Radiology*, April, 1943, 40, 351-361.

There has been enough evidence of primary infective non-bacterial pneumonia to establish it as a clinical entity. There has been considerable success in the isolation of a psittacosis or related virus in some cases.

The authors discuss 27 cases that they have seen, with case histories and roentgenograms of 5 cases belonging to three typical groups of mild, severe and migrating. The latter spreads rapidly from one area to another. There was only 1 death among the 27 cases.

The clinical symptoms are sore throat, severe headache, generalized aching, drenching sweats and severe paroxysmal coughing. There have been few physical findings except moist râles at the bases posteriorly. The leukocyte count was low, sometimes showing leukopenia. Sputum examination failed to show any bacteria responsible for the disease and typing with pneumococcus serum was negative. The cases did not respond to sulfonamide treatment.

The roentgen findings are of great value in diagnosis but require the support of clinical evidence. Without it they might be mistaken for tuberculosis. The typical roentgen picture is that of diffuse, irregular, patchy densities with feathery edges extending out from the hilum. There is generally some coalescence but large areas of consolidation are rarely seen.—*Audrey G. Morgan.*

HILLEBOE, HERMAN E. Use of small x-ray films in tuberculosis control. *Radiology*, March, 1943, 40, 297-301.

Mass examinations for tuberculosis became increasingly important with the advent of war. All recruits for the Army and Navy are now tested and similar examinations will soon be made of Coast Guard recruits. But it is also increasingly important to examine the civilian population as the danger of tuberculosis is increased by large-scale concentrations of industrial workers and their families, employment by industry of thousands of women and other workers who are not accustomed to heavy labor and fatigue and insufficient rest as a result of the heavy demands of the work.

Examination with the ordinary 14×17 inch film is too expensive and too time consuming for this work. The use of 35 mm. photofluorograms has been substituted in mass examination because of its cheapness and rapidity. The Office of Tuberculosis Control has established eight survey units for this purpose which are now loaned to industries free of cost. Each is in



charge of an officer of the United States Public Health Service who is a specialist in the interpretation of 35 mm. films. It has been demonstrated that less than 10 per cent of cases with minimal lesions are missed. As only about a third of these are found significant the percentage is really nearer 3 per cent. With adequate treatment facilities tuberculosis can easily be controlled if this percentage of early cases can be detected.

The purpose of the small film examination is not to diagnose tuberculosis but to screen out cases with slight lesions for further examination. All abnormal or suspected cases are re-examined with large films. In the course of the tuberculosis examinations other unsuspected pathological conditions are often discovered.—*Audrey G. Morgan.*

#### ABDOMEN

ROSS, JOHN A. A note on amoebic hepatitis. *Brit. J. Radiol.*, Jan., 1943, 16, 30.

A raised dome of the diaphragm suggests amoebic hepatitis if the patient has been abroad. Sometimes patients complain only of slight tenderness in the right hypochondrium; there is only slight rise of temperature and a history of diarrhea. The liver may be enlarged upward and not palpable in the abdomen. Screen examination may show decreased movement of the right or left domes of the diaphragm. The raised dome may show an abnormal outline due to the amoebic abscess. The lungs may show congestion with or without effusion. Usually the right dome is raised and the lung signs are at the right base. After emetine treatment the diaphragm resumes its normal position. Roentgenograms should be made so that the excursion of the diaphragm can be measured before and after treatment. Details of the method of taking the roentgenograms are given.—*Audrey G. Morgan.*

ELKELES, A., and JAMES, J. I. P. Calcified non-parasitic cyst of the spleen. *Brit. J. Radiol.*, Feb., 1943, 16, 59-60.

Non-parasitic cysts of the spleen are rare, only 137 having been reported up to 1939. A case is reported in a soldier, aged forty-one, who complained of sharp, jabbing pain in the left hypochondrium, which he had had for about fourteen weeks. For a number of years he had had attacks of vomiting after meals and about twenty-five years ago had had an attack of what appeared to be acute catarrhal jaundice. No history of injury.

A plain roentgenogram of the abdomen showed a large round cyst the size of an orange in the left upper quadrant. Its outline was distinct and it was calcified. Its upper pole was in contact with the left diaphragm which was slightly elevated. On roentgenoscopic examination the cyst moved with the restricted movement of the diaphragm on respiration. After a barium meal the stomach was displaced to the right and the cyst lay above the splenic flexure which was pushed downward. The left kidney was displaced downward. Operation showed the spleen enlarged with a calcified cyst at the upper pole. Recovery was uneventful.—*Audrey G. Morgan.*

ZWERLING, HENRY, and NELSON, WALDO E. The roentgenologic pattern of the small intestine in infants and children. *Radiology*, March, 1943, 40, 277-282.

Certain variations from what is considered normal have been found in the roentgen picture of the small intestine in children with nutritional deficiency, such as coarsening or obliteration of the mucosal markings, segmentation, irregular flocculation and in some cases dilatation. In gastrointestinal allergy the pattern is that of hypertonicity with narrowing of the lumen. But a similar intestinal pattern has been found in normal newborn infants and it has been claimed that the transition from the infantile to the adult pattern occurs at the age of four to five months.

The authors examined 77 children from three months to eleven years old. Twenty were from a well baby clinic, 45 from an orphanage and 12 from families in good economic circumstances.

Barium was given and roentgenograms taken thirty minutes later and after that at intervals of thirty to sixty minutes until the barium had passed to the distal ileum or cecum. The roentgenograms are reproduced. The only child who showed a definitely adult type of marking was the one that had a nutritional disturbance. All of the signs described above as being infantile or due to deficiency states were found in varying degrees in the majority of cases. Apparently a diagnosis of deficiency states in children cannot be based on the roentgen appearance of the small intestine.—*Audrey G. Morgan.*

JACKMAN, RAYMOND J., and SMITH, NEWTON D. Some manifestations of regional ileitis observed sigmoidoscopically. *Surg., Gynec. & Obst.*, April, 1943, 76, 444-445.

Ever since Crohn and his co-workers established regional ileitis as an entity in 1932, the authors have been impressed with the frequency of certain anorectal manifestations of the disease. The records of 114 consecutive cases of regional ileitis in which the diagnosis was made by roentgenologic examination and confirmed by exploration were reviewed. Sigmoidoscopic examinations were done on these cases. The purpose of the review was to note the lesions of the lower part of the bowel which are more or less peculiar to the disease.

*Anal Abscess and Anal Fistula.* Thirty-six, or 31.6 per cent of the 114 patients, had anal abscess or anal fistula, or they gave a history of having had an operation for anal fistula within a period of three years prior to their visit to the Mayo Clinic. With increased alertness to the possibility of coexistence of the two conditions, even more cases of regional ileitis could be found among patients whose primary complaint is anal abscess or anal fistula.

*Extrarectal Mass.* A mass was palpable in the rectovesical or rectouterine space in 20, or 17.5 per cent of the 114 cases. This mass represents an involved segment of diseased ileum, perhaps complicated by pelvic peritonitis and diffuse fistulous tracts.

*Anal Ulceration and Anal Contraction.* Nine, 7.8 per cent, of the 114 patients studied had anal ulcerations or anal contracture.

*Ulceration in Lower Part of the Bowel after Short Circuiting Operations.* On sigmoidoscopic examination of 4 patients (3.5 per cent of the group) one to two years after short circuiting operations, ulcerations were found in the lower part of the bowel.—*Mary Frances Vastine.*

HELWIG, ELSON B. Benign tumors of the large intestine—incidence and distribution. *Surg., Gynec. & Obst.*, April, 1943, 76, 419-426.

This report is based upon 1,460 consecutive autopsies in which the entire large intestine was available for study. The study is from the Department of Pathology, Washington University School of Medicine, St. Louis.

The number of cases and the various types of polyps encountered in the large intestine in this series are as follows:

1. *Adenomas.* There were 139 adenomas, an incidence of 9.5 per cent. In 80 instances there were single adenomas and in 59 cases 2 or more adenomas were present. The sigmoid colon is the most common site in the large intestine for the occurrence of adenomas. The adenomas

may be either sessile or pedunculated. A few were as small as 1 mm. in diameter and the largest measured 9 cm. in the greatest diameter.

2. *Lipomas.* In the 1,460 consecutive large intestines, 13 contained lipomas, an incidence of 0.89 per cent. Ten showed a solitary lipoma and 3 contained 2 or more. Ten of the lipomas were located in the large intestine, an incidence of 0.25 per cent. The cecum and the contiguous ascending colon are the most common sites of lipomas in the large intestine. Lipomas of gastrointestinal tract are about equally divided in the sexes. The incidence of lipomas is greatest in the same decades in which adenomas and carcinomas are most common, i.e. in patients over fifty years of age.

3. *Leiomyoma.* Only 1 tumor composed of smooth muscle was encountered in this series of 1,460 autopsies. It was located in the sigmoid colon of a man aged sixty-seven.

4. *Carcinoid.* The fourth type of polyp encountered in this series was the carcinoid or argentaffinoma. It occurs most commonly in the appendix and less frequently in the ileum. It is a decidedly uncommon tumor. In the present report the tumor was located in the rectum of a man fifty-six years old.—*Mary Frances Vastine.*

#### GYNECOLOGY AND OBSTETRICS

DICKINSON, KENNETH, and PROCTER, IVAN M. Comparative measurements of the female pelvis. *Am. J. Obst. & Gynec.*, Oct., 1942, 44, 585-591.

This study is undertaken with the purpose of comparing the anteroposterior diameters of the pelvis obtained by the four methods which can be used: (1) The diagonal conjugate may be obtained and the true conjugate estimated from it by subtracting 1.5 to 2 cm. (2) Roentgen rays may be directed into the pelvic inlet by the technique of Thoms, Torpin, and others. (3) Roentgen rays may be directed lateral to the pelvic inlet by the technique of Thoms, Jacobs and others. (4) The patient may be operated upon and the true conjugate measured directly.

#### *Results of Comparative Measurements.*

In 83 per cent of the cases the anteroposterior view compared favorably with the lateral view, i.e. the anteroposterior diameter was the same in both, allowing an error of 4 mm.

In 40 per cent of the cases measured by the first roentgen-ray technique and in 41 per cent of the cases measured by the second roentgen-ray technique, the operative and roentgen-ray measurements were the same. This is not a high

degree of accuracy. The disagreement in the remaining 60 per cent may be explained by the fact that the roentgen ray measures bone-to-bone only, and any other technique, including the measurements made at the time of operation, includes soft tissue-to-soft tissue measurement.

One subtracts 1.5 to 2 cm. from the diagonal conjugate to obtain the true conjugate. The diagonal conjugate and the true conjugate measured by the roentgen ray and at the time of abdominal operation were compared. The figures obtained would seem to show that so far as the clinical evaluation of the pelvis is concerned one would be nearer correct in 80 per cent of these cases if the unmodified diagonal conjugate were accepted as the same as the roentgen-ray true conjugate.—*Mary Frances Vastine*.

STEELE, KYLE B., and JAVERT, CARL T. Classification of the obstetric pelvis based on size, mensuration, and morphology. *Am. J. Obst. & Gynec.*, Nov., 1942, 44, 783-798.

In this communication the authors consider the classifications of the obstetric pelvis as well as the methods of diagnosis and a method of approach is outlined which combines the best features of each. They conclude that:

(1) Size and morphology constitute the most practical basis for classification of the obstetric pelvis.

(2) Mensuration, utilizing roentgen pelvimetry, serves primarily to determine size. Size is an index of morphology in an unusually large percentage of contracted pelvises which are often of the android, platypelloid, or small gynecoid types.

(3) Roentgen pelvimetry in 1,000 cases has demonstrated that 30 per cent were contracted in contradistinction to an incidence of 15 per cent detected by clinical pelvimetry.

(4) Morphology can be most easily and most accurately determined by the direct study of form using the precision stereoscope.

(5) All forms encountered must be provided for in a formal classification. The terminology of Caldwell and Moloy has been employed because it provides for the recognition of pure and mixed types. The terms have correct etymology. Care must be utilized when combining their nomenclature with that of Thoms. While the terms "dolichopellic" and "anthropoid," "platypellic," and "platypelloid" are interchangeable, there is still some question regarding the

admissibility of doing so with the "brachypellic" and "gynecoid," and the "mesatipellic" and "android" types.

(6) The problem presented by the irreducible multiplicity of form can be lessened by individual classification of the anterior and posterior segments of the inlet.

(7) The combined isometric and stereoscopic technique provides an excellent opportunity for the determination of size and for the study of morphology of the obstetric pelvis.

(8) Clinical pelvimetry, using revised concepts, has shown considerable promise and is being investigated further. In this, the posterior transverse diameter should prove of assistance in detecting the android posterior segment.—*Mary Frances Vastine*.

LECHENGER, G. C. Roentgen pelvimetry and fetometry: a new formula. *Radiology*, June, 1943, 40, 589-593.

In May, 1941, Dippel and Delfs published an article on "The accuracy of roentgen estimates of pelvic and fetal diameters." They criticize methods formerly in use and suggest a method of their own based on the familiar stereoscopic tube shift technique. They use a marker or template of known length placed so that its image will appear on each of the stereoscopic films.

The author suggests a method based on their technique which reduces the problem of pelvimetry and fetometry to a single formula. Diagrams and mathematical formulae used in its application are given. He gives full credit to Dippel and Delfs. His experience has shown the practicability of the method and Dr. Dippel has checked the mathematics and used the method clinically in a number of cases. He reports that the results have been accurate and the application of the method not difficult. It is not necessary for the patient to assume any unusual or uncomfortable position. If there is an evident error the calculations can be rechecked without making any further roentgenograms.—*Audrey G. Morgan*.

MORTON, DANIEL G. Observations of the development of pelvic conformation. *Am. J. Obst. & Gynec.*, Nov., 1942, 44, 799-819.

The direct study of 27 fetal pelvises of various ages and the roentgenometric study of 143 children of both sexes, from three to seventeen years of age, revealed the following interesting observations:

*The Shape of the Pelvic Inlet.* (1) The shape of the inlet was found to be broader than long at all periods of *fetal life*; (2) the inlet was still either broader than long or round in most instances in *children under six years of age*; (3) the pelvic inlet was invariably longer than broad *from six to eleven years of age*; (4) the outline of the pelvic inlet was not smooth but showed an inward bowing in the acetabular regions in all of the *children of prepuberty age*; (5) the pelvic inlet of the female pelvis showed a tendency to flattening so that many of them again become broader than long *after puberty*. The bowing in the acetabular regions was not noted in the postpuberty group or in the fetal pelvises.

*Sex Differences.* (1) No significant sexual differences were observed in the *fetal period*; (2) only two possible differences were revealed in the *years before puberty*: (a) a shorter posterior segment at the pelvic inlet in the male and (b) a downward angulation of the sacrum in the male; (3) the well-known characteristics of the adult male and female pelvises were observed *after puberty*.—*Mary Frances Vastine.*

BAYLIN, GEORGE J., and LAMBETH, SAMUEL S. Roentgen diagnosis of placenta praevia. *Radiology*, May, 1943, 40, 497-500.

Vaginal bleeding is quite common in the last third of pregnancy and the possibility of placenta previa must always be considered. The dangers of determining the position of the placenta by pelvic examination are obvious. These can be obviated by the use of soft tissue roentgenography. Snow takes three films of all late pregnancy cases, the conventional anteroposterior and lateral roentgenograms plus a soft tissue lateral view. He injects 200 cc. of air into the bladder to afford greater contrast between the placenta and the surrounding tissues.

The technique for taking soft tissue roentgenograms is not difficult and does not require elaborate equipment. A low kilovoltage with relatively short exposure time gives roentgenograms of sufficient contrast to make the anatomical structures visible. The wall of the uterus and the mother's abdominal wall can be seen easily and as the placenta generally occupies 20 to 30 per cent of the surface of the endometrium it also can be identified readily. It appears as a thickened soft tissue shadow fused with the wall of the uterus. A thorough knowledge of the normal structures is necessary for accurate roentgen diagnosis. Air in the bladder has proved helpful according to one ob-

server but it is not necessary. The chief causes of inaccurate visualization seen by the author have been hydramnios, multiple pregnancies, breech presentations and poor films.

Illustrative roentgenograms are given.—*Audrey G. Morgan.*

#### SKELETAL SYSTEM

BUDD, JOHN W., and MACDONALD, IAN. A modified classification of bone tumors. *Radiology*, June, 1943, 40, 586-588.

This modified classification of bone tumors is presented by the Los Angeles Tumor Institute. It is based on the histogenetic origin of the tumors, the type of tissue from which they are derived. There has previously been great carelessness in the use of words in the classification of these tumors. For instance, the word osteogenetic has been used loosely to mean tumors derived from bone or tumors which produce bone. The authors think it should be used to indicate only tumors originating in bone, regardless of whether they produce bone or not. They also think that the fact should be recognized that connective-tissue sarcomata of bone are divisible into three main types and that fibrosarcoma should rank as equivalent to osteosarcoma and chondrosarcoma, though less frequent. The classification is as follows:

Type of tissue	Malignant	Benign
1. Connective	Osteosarcoma Chondrosarcoma Fibrosarcoma	Osteoma Chondroma
2. Undetermined	Malignant giant cell tumor	Benign giant cell tumor Epiphyseal chondromatous giant cell tumor
3. Endothelial	(a) Angio-endothelioma (b) Diffuse endothelioma (Ewing's sarcoma)	(a) Plexiform angioma (b) Cavernous angioma
4. Hematopoietic		
Erythropoietic	(a) Erythrocytoma	
Myeloid	(b) Myelocytoma; myeloma	
Lymphoid	(c) Lymphocytoma	
Reticular	(d) Reticuloeytoma	
5. Adipose	Liposarcoma	

—*Audrey G. Morgan.*

HALDEMAN, KEENE O. Development of bone in relation to the formation of neoplasms. *Radiology*, March, 1943, 40, 247-252.

The author discusses a theory of the formation of bone tumors for which he gives chief credit to Geschickter and Copeland, who first stated it in their text on "Tumors of Bone."

In the embryo, bones are formed by the differentiation of mesenchymatous cells. The bones of the face and vault of the skull ossify directly from the mesenchyme. In all other bones the development of bone is preceded by that of hyaline cartilage. Up to about the age of twenty-one a plate of hyaline cartilage remains between the epiphysis and shaft of the bones from which growth of the bone takes place. Most bone tumors, either benign or malignant, begin at the site of transition from cartilage to bone. The tumor cell may resemble precartilaginous connective tissue, the cartilage cell or the osteoclast and osteoblast which bring about the actual formation of bone. Bone tumors are not the result of the failure of the process of bone repair to be arrested, that is, they do not result from trauma and fracture, but result from a distortion of the normal process of the change from cartilage to bone.

In the discussion Dr. Bromer presented the arguments for the action of trauma as one of the factors in producing tumors of bone.—*Audrey G. Morgan.*

LUCK, J. VERNON. A correlation of roentgenogram and pathological changes in ossifying and chondrifying primary osteogenic neoplasms. *Radiology*, March, 1943, 40, 253-276.

Correlation of the findings of clinician, pathologist and roentgenologist is of vital importance in the study of bone tumors. Neither one alone can solve all the complicated problems involved in the study of these neoplasms.

This discussion is limited to bone tumors which produce bone or cartilage. The benign forms include osteomas, spongy, eburnated and osteoid, chondromas, solitary and multiple and osteochondromas, solitary and multiple hereditary. The malignant tumors are osteogenic sarcomata, including osteoblastic sarcoma and chondrosarcoma, the former subdivided into sclerosing and osteolytic and the latter into primary and secondary. Giant cell tumors, multiple myelomata and endothelial myelomata are excluded because they do not produce bone or cartilage. Osteogenic fibromata and fibrosarcomata have been known to produce bone and cartilage but they do it so rarely that they too are excluded.

The different types of tumor that are included are taken up separately and a wealth of detail in regard to the roentgen findings given; the article is illustrated with photomicrographs

and roentgenograms of the different types of tumor, from a study of which an idea can be obtained of the correlation between the roentgen and pathological findings.—*Audrey G. Morgan.*

SHACKELFORD, RICHARD T., and BROWN, WEBSTER H. Osteochondroma of the coronoid process of the mandible. *Surg., Gynec. & Obst.*, July, 1943, 77, 51-54.

Two cases of osteochondroma of the coronoid process of the mandible are reported. The authors could find no previous reports in the literature of osteochondromas occurring in this particular location. In neither of these 2 cases did routine examination by roentgenograms show the tumor or else its true nature went unrecognized. In the discussion of osteochondromas, the following points are noted:

1. In general, osteochondromas are common tumors appearing usually between the ages of ten and twenty-five years; but some are thought to be congenital.

2. They are benign.

3. They frequently occur near the ends of the long bones, particularly at the site of attachment of the tendon which supplies the maximal degree of traction. A possible reason for this characteristic location is that at such a point a defect in the periosteum permits precartilaginous blastomas to escape or to be pulled out from the limiting membrane and in time these cells produce the osteochondroma.

4. The tumor characteristically has a stalk of normal appearing bone which terminates in a mushroom-shaped head that is capped with a layer of cartilage.

5. The tumors described in this paper were situated on top of the coronoid process, the site of insertion of the powerful temporal muscle. Except for this unusual location they were similar, pathologically and in rate of development, to osteochondromas found elsewhere.

6. A roentgenogram of one of the cases reported reproduced in the article depicts expansion of the coronoid process and erosion of the zygomatic arch. In order to obtain this view it is necessary that the patient's head be partly rotated and the rays directed tangentially to the side of the head. The exact amount of angulation can be estimated after the taking of scout films and fluoroscopic examinations of the head and face. This projection produces some distortion but does supply the maximum amount of detail.—*Mary Frances Vastine.*

FURST, NATHAN J., and SHAPIRO, ROBERT. Polyostotic fibrous dysplasia: review of the literature with two additional cases. *Radiology*, May, 1943, 40, 501-515.

In Recklinghausen's monograph on fibrocystic disease of bone published in 1882 it is evident that he described a number of unrelated pathological conditions which have in common only the occurrence of fibrocystic-like bone changes. Some of these cases may have been ones of polyostotic fibrous dysplasia. A knowledge of this disease was first popularized in this country by the work of Albright and his co-workers in 1937 and Lichtenstein in 1938. It is characterized by endocrine dysfunction, pigmentation and precocious puberty associated with polyostotic fibrous dysplasia. Its etiology is not definitely known. The various theories in regard to it are discussed and the conclusion reached that it is probably due to some hypothalamic lesion in the region of the third ventricle which produces secondary lesions in the anterior lobe of the pituitary, resulting in abnormal stimulation of its hormones.

Clinical diagnosis is impossible without roentgen examination. There is some tendency for the bone changes to be unilateral, though they may be bilateral. There is no generalized decalcification; the lesions are spotty, with normal bone between diseased areas. The characteristic lesions are areas of rarefaction resembling bone cysts, but they are not true cysts. The roentgen appearance is due to the replacement of bone by fibrous tissue. There are also areas of increased density. There is marked thinning of the cortex with broadening or expansion of the diseased bones. Periosteal reaction rarely occurs except at the site of fracture. Pathological fractures occur frequently. The skull may be involved in various ways and the appearance may not be unlike that of Paget's disease.

Two typical cases are described and illustrated with roentgenograms.—Audrey G. Morgan.

LINSMAN, JOSEPH, F., and McMURRAY, CRAWFORD A. Fluoride osteosclerosis from drinking water. *Radiology*, May, 1943, 40, 474-484.

It has long been known that an excess of fluoride in the drinking water causes mottled teeth but it has not been realized that osteosclerosis of the bones might be due to the same cause.

The authors describe a case in a white, older, eighty-two years of age who had grown up and

lived for years in communities with excess of fluoride in the drinking water. He came for treatment for a chalazion of the right upper eyelid but examination June 18, 1942 showed a severe anemia. He had mottled tooth enamel; tests showed defective kidney function, and roentgen examination showed marked osteosclerosis of the bones, particularly those of the pelvis, spinal column, ribs and sternum. He died September 17 and autopsy showed chronic bilateral pyelonephrosis, bilateral hydroureter with ureteritis, acute cystitis, abscesses of the prostate, sclerosis of bones, dental fluorosis and hyperplasia of the bone marrow.

The great danger in fluoride osteosclerosis is that anemia will be caused by encroachment of the hardened bone on the marrow cavity. Unfortunately the sclerotic changes are most severe in the bones in which most of the blood is normally formed. Roentgenograms in these cases show considerable increase in density and coarsening of the trabecular patterns.

In the case described it is possible that chronic fluoremia may have aggravated kidney lesions that already existed or it may be that the osteosclerosis developed as a result of fluoride retention caused by the kidney lesions.

At any rate the existence of more than three parts of fluorine in a million parts of drinking water is a menace to public health and should be taken into account by public health authorities. Roentgen examinations of the skeleton should be made in all patients with dental fluorosis and anemia or defective kidney function in order to determine whether there is a fluoride osteosclerosis. A map of the United States is given showing the areas in which there is an excessive fluorine content in the water. —Audrey G. Morgan.

MACEY, HARRY B., and PHAGEN, GEORGE S. Metastatic lesions of the sternum. *Surg. Gynec. & Obst.*, April, 1943, 76, 451-455.

Tumors involving the sternum are not common. In the files of the Mayo Clinic there are 14 cases of neoplastic involvement of the sternum: 4 primary chondrosarcomas, 2 mixed blastosarcomas, 1 endothelioma, and 7 metastatic tumors. Of the 7 metastatic tumors, 1 is from a carcinoma of the breast, 1 from a sarcoma of the thorax, 1 from a carcinoma of the thyroid, 1 from a carcinoma of the stomach, 1 from a carcinoma of the rectum, 1 from a hypernephroma, and 2 are from a possible primary pulmonary neoplasm. The last 2 cases are reported by the authors.



since no similar cases have been recorded in the literature.

The importance of taking roentgenograms of the sternum in all cases of sternal pain is stressed. If a destructive lesion of the sternum is seen in the roentgenogram, an adequate specimen for biopsy must be taken to determine, first, the benignancy or malignancy of the condition, and second, the feasibility of complete surgical extirpation.—*Mary Frances Vastine*.

DEERY, EDWIN M. Herniation of the nucleus pulposus as a complication of pre-existing low back instability. *Surg., Gynec. & Obst.*, July, 1943, 77, 79-86.

In addition to uncomplicated herniation of the nucleus pulposus, this condition occurs as a complication of low back instability. A more general recognition of such combined problems than exists at present is needed. The diagnosis of herniated nucleus is discussed in some detail and this is the part of the study which is probably of most interest to the roentgenologist.

*History.* The history of herniated nucleus is that of pain along the course of the sciatic nerve. While the history is very characteristic it is of course not diagnostic. Pain along the front or lateral aspect of the leg is not sciatic pain. Sciatic pain is increased by all back movements and by coughing or sneezing. It may or may not be improved by bed rest. It is generally unrelieved or made worse by physiotherapy. It is considerably increased when the patient bends toward the side of the pain.

*General Features.* If the patient is seen in a severe attack of pain there is generally a protective limp and the back is bent forward. There is a flat low back from loss of the normal lumbar lordosis and the lumbar spine tends to curve away from the side of the pain.

*Neurological Signs.* 1. Motor signs. Muscle strength. The majority of these patients will show a little weakness in dorsiflexion of the foot on the affected side.

2. Muscle atrophy. Careful measurements made at 15 cm. above and below the patella of the affected leg will usually show slight atrophy. Atrophy of the gluteal muscle on the painful side is very often found.

3. Reflex changes. Almost all patients have a reduced to absent ankle jerk yet the location of the herniated nucleus is not always at the fourth-fifth lumbar interspace.

4. Sensory changes. Most of the patients will

show characteristic sensory changes along the outer side of the lower leg and on the foot. The outer side of the lower leg as well as the outer side of the ankle and foot can be considered the area supplied by the first and second sacral nerves. If the sensory changes are limited to this area the herniated nucleus will generally be found at the lumbosacral interspace. If, in addition, there are sensory losses on the inner side of the foot, from toe to heel, which is the area supplied by the fifth lumbar, the nucleus will be found at the fourth-fifth lumbar interspace. Since the majority of herniations occur at the fourth-fifth lumbar interspace sensory changes will usually involve the fifth lumbar, first and second sacral skin areas.

*Roentgen Findings.* A narrowed intervertebral space is not a reliable guide to either the presence or the level of a herniated nucleus. The herniation can occur with a normal intervertebral space. In the group of cases with the herniated nucleus pulposus as a complication of a low back instability the orthopedic instability and narrowed intervertebral space were generally at the lumbosacral level whereas the herniated nucleus was usually found at the fourth-fifth lumbar interspace. Sensory testing was found to be the reliable guide to the level of the herniated nucleus regardless of the narrowed space.

*Lipiodol.* Lipiodol has not been used in the New York Orthopaedic Hospital and Dispensary for making the diagnosis of herniated nucleus as it has not been found necessary. A negative lipiodol study is not reliable proof of the absence of a herniated nucleus pulposus. Unless the surgeon is willing to operate upon the basis of real neurological signs, many patients with a negative lipiodol report will continue to have their herniated nucleus and the pain it produces.—*Mary Frances Vastine*.

KELIKIAN, H. Chronic arthritis. *Surg., Gynec. & Obst.*, April, 1943, 76, 469-479.

Rheumatoid arthritis and osteoarthritis are compared under the following headings:

#### *Synonyms.*

Rheumatoid arthritis—atrophic, proliferative, infectious, inflammatory, etc.

Osteoarthritis—hypertrophic, degenerative, traumatic, senile, etc.

#### *Etiologic Relations.*

Rheumatoid arthritis—Under forty; pale asthenic women; foci of infection.



Osteoarthritis—Over forty; robust laborers; acute or chronic trauma.

#### *Systemic reactions.*

Rheumatoid arthritis—Fever; leukocytosis perhaps plus sedimentation rate.

Osteoarthritis—Absent.

#### *Joints Predilected.*

Rheumatoid arthritis—Those rich in primitive connective tissues—joints with extensive synovial membrane and bulbous articular ends, like the proximal interphalangeals.

Osteoarthritis—Weight-bearing, traumatized joints and those poor in circulation, like the distal interphalangeals.

#### *Symptoms.*

Rheumatoid arthritis—Pain and stiffness marked; many joints involved.

Osteoarthritis—Pain and stiffness relatively mild; one, or at most, a few joints affected.

#### *Pathology.*

Rheumatoid arthritis—

A. Primary: Inflammation of relatively primitive vascular connective tissues of the joint—of synovial membrane and bone marrow.

B. Secondary: Displacement or atrophy of specialized elements of the joint—of cartilage and bony trabeculae.

Osteoarthritis—

A. Primary: Wearing down of specialized elements of the joint—of cartilage and underlying bone.

B. Secondary Reactive process at the margins in the form of spurs.

#### *Roentgen Findings.*

Rheumatoid arthritis—Fusiform enlargement of soft part; disappearance of cartilage space along the margins; osteoporosis, subluxations, contractures, and ankylosis.

Osteoarthritis—Broadening of articular surfaces of bones; disappearance of the space in central areas and sclerosis of bone below; spurs, cystic areas, loose bodies.

#### *Rationale of Treatment.*

Rheumatoid arthritis—Regard the patient as a systemic disease and treat the patient as a whole.

Osteoarthritis—Direct attention to the joint itself; undertake measures to save it from wearing down.

#### *Surgery.*

Rheumatoid arthritis—Aim at putting a painful joint at rest (splintage), overcoming contractures (traction, turnbuckle splint, manipulation, capsulotomy, osteotomy, ostectomy, etc.); eradication of residual inflammation (synovectomy); mobilization of an already ankylosed joint (arthroplasty); and elimination of very painful one (arthrodesis).

Osteoarthritis—Indicated in presence of painful loose bodies (arthrotomy); when there are incongruities of surfaces that might beneficially be eliminated (erosion, arthroplasty); when there are chances of proffering a better weight-bearing surface (corrective osteotomy); when the joint has crumbled down and is painful (arthrodesis).—*Mary Frances Vaseline.*

HARMON, PAUL H. Arthroplasty of the hip for osteoarthritis utilizing foreign-body cups of plastic. *Surg., Gynec. & Obst.*, March, 1943, 12, 347-365.

Late results, approximately eighteen months following foreign body cup arthroplasty of the hip in osteoarthritis, utilizing a plastic methacrylate cup are reported in 13 cases (16 hips). The results have been excellent in 10 hips, or 62.5 per cent. The author discusses in some detail the alterations which occur in the osteoarthritic femoral head as well as the etiology and pathogenesis of osteoarthritis.

#### *Gross and microscopic alterations of the osteoarthritic femoral head.*

Early changes include;

1. Marginal osteophytes at the head-neck junction or at the lateral acetabular margin.
2. Widening of the head by growth of the adductor portion of the head.
3. Sclerosis within the head and above the acetabular articular bony cortex.
4. Cartilage space normal or slightly diminished.

Later changes include:

1. Spotty sclerosis appears in the head denoting osseous infarction or endosteal proliferation.
2. Marginal osteophytes increase in size.
3. The adductor portion of the head becomes disproportionate. In advanced cases the adductor osteophyte may be half as large as the head itself and may cause partial dislocation of the head.

4. Irregular islands of cartilage thinning occur. Cartilage is thrown up into pleat and ridge formation.

*Etiology and pathogenesis of osteoarthritis.*

The fundamental lesion in osteoarthritis or degenerative arthritis is the change that takes place in the articular cartilage. Whether osseous infarction occurs first or cartilage degeneration precedes it is immaterial as the end-result is the same, i.e., degeneration and fibrillation of cartilage and thickening and sclerosis of subchondral bone.

1. Thirty-seven of the 94 patients upon whom records were available at the Guthrie Clinic and the Robert Packer Hospital, Sayre, Pennsylvania, were assigned to the group of secondary osteoarthritis. The other 57 cases were classed as primary.

2. The mean age in the group of patients with primary osteoarthritis of the hip was sixty-four years while that of the secondary cases was forty-five years.

3. The incidence of osteoarthritic changes in other joints in the primary group was four times as common as in the group of secondary cases.

4. The disease was unilateral in all the secondary cases, except those following protrusio acetabuli, rheumatoid arthritis, Paget's disease, and slipped upper femoral epiphysis.

5. Obesity of a significant degree was present in one-third of the cases, and the body build in almost all the patients could be described as "large."

6. Foci of infection, generalized arteriosclerosis, cardiac disease, anemia, and increase in the blood sedimentation rate were encountered occasionally but not with a frequency that would implicate them as causative of the condition.

7. Save for the joint condition, the majority of these patients were in unusually good physical condition.—*Mary Frances Vastine.*

HOUKOM, S. SVERRE. Tuberculosis of the ankle joint; end-result study of twenty-five cases. *Surg., Gynec. & Obst.*, April, 1943, 76, 438-443.

At the New York Orthopaedic Hospital it has been the impression that the results of surgical fusion for tuberculosis of the ankle joint are uniformly good. In an attempt to secure a better evaluation of the end-results, a study was made of the 25 cases of tuberculosis of the ankle joint in patients treated from 1923 to 1938 inclusive.

*Clinical Findings.* (1) The age varied from fourteen months to forty-five years. The average age of onset was 13.5 years. (2) The usual presenting symptoms included; pain, swelling, fluctuation, increased local heat, muscle spasm, limitation of motion, equinus deformity, sinuses and a unilateral limp.

*Diagnosis.* (1) The roentgen findings are of considerable help in establishing the diagnosis, the important feature being a general decalcification of the bone with an associated well defined joint effusion. The presence of bone atrophy, thinning of the joint space, erosion of the articular cortex, and, in the more advanced cases, actual destruction of the bone are also helpful. (2) The sedimentation rate is elevated. (3) The Mantoux test is positive. (4) A positive diagnosis was established in all these cases by the pathologist.

*Previous Treatment.* The most common forms of treatment were incision and drainage of abscesses, leg casts, and braces.

*Treatment.* Immediate arthrodesis of a tuberculous joint is recommended at the New York Orthopaedic Hospital unless the general condition contraindicates it.

*Pathology.* (1) The joint capsule frequently bulges anteriorly and is thickened and edematous. (2) The synovial membrane is replaced by grayish yellow avascular friable granulation tissue. (3) The articular cartilage is often thin, lacking luster and is easily separated from the underlying bone. (4) Cavities in the adjacent bone of the talus or tibia are frequently present and filled with bone debris, caseation or granulation tissue.

*Conclusion.* (1) Arthrodesis is the treatment of choice for tuberculosis of the ankle and talocalcaneal joint regardless of age. (2) In younger patients with extensive bone destruction or in poor general condition, a preliminary rest period of four to six months may be advisable. (3) The average period of disability (1.2 years) when this form of treatment is used is much less than when a conservative regimen is followed. (4) Amputation is rarely if ever indicated in the treatment of tuberculosis of the ankle.—*Mary Frances Vastine.*

LAPIDUS, PAUL W. Lesions of the inconstant sesamoids of the foot. *Radiology*, June, 1943, 40, 581-585.

Five cases are described and illustrated with roentgenograms which show that the small and inconstant sesamoid bones of the foot may

cause severe pain and even disability. In a woman of thirty-three severe pain developed after stepping on a small, sharp pebble. After unsuccessful conservative treatment by padding for several weeks operation was performed and revealed fracture of the inconstant left second tibial sesamoid. An undivided sesamoid of the same size was found on the right side. Three cases of congenital bipartite sesamoids are described and 1 case of calcareous tendinitis of the tendons near the sesamoid of the left second toe. The patient in this case was a dancer who had severe pain beneath the ball of the left second toe. She had suffered no definite injury but had practiced dancing exercises several hours a day. Roentgenograms showed a normal well-formed sesamoid similar to the one on the opposite side except for several irregular calcareous deposits in the tendons around the bone. The sesamoid and the calcareous deposits were removed surgically and after three months the patient was able to resume dancing.—*Audrey G. Morgan.*

#### ROENTGEN AND RADIUM THERAPY

CROWELL, BOWMAN C. The role of the cancer clinic in cancer control. *Radiology*, June, 1943, 40, 539-542.

The author emphasizes the importance of cancer clinics in the general hospitals throughout the country, both for providing more adequate treatment for this disease and for giving instruction to the public so that cases may come for treatment earlier. There are now more than 380 clinics that conform to the minimum standard established by the American College of Surgeons. This standard requires that there shall be a definite organization of the service, including an executive officer and a representative of each of the departments of the hospital concerned in the diagnosis and treatment of cancer. There must be regular conferences or consultations at which the diagnosis and treatment of individual cases are discussed by all members of the clinic who are concerned with the case. There must be close cooperation between the departments of radiology, pathology, surgery and the surgical specialties. The author believes that cancer is still primarily a disease for surgical treatment but he recognizes the great contribution made by radiology to its control.

Though in the ten years since this movement was initiated there has been an increase in the number of five year cures of cancer, the annual

cancer mortality is still increasing. At the present mortality rate a million and a half persons will die of cancer in the United States in the next ten years. The present preoccupation with the war should not be allowed to interfere with the cancer control program as cancer control is a measure for the conservation of man power.—*Audrey G. Morgan.*

KRESS, LOUIS C., and LEVIN, MORTON L. Experiences and results in tumor clinic organization in New York State. *Radiology*, June, 1943, 40, 543-548.

In meeting the problem of cancer control the tumor clinic has long been a powerful weapon in upstate New York. A Commission was appointed in 1937 to study the cancer situation and make recommendations in regard to it. One of the chief recommendations was that encouragement be given to the establishment of cancer clinics in general hospitals. Legislation was enacted reorganizing the Division of Cancer Control and making cancer a reportable disease. It was believed that enough cancer clinics should be established so that no patient would have to travel more than 50 miles to reach one, for the shorter the distance the patient must travel, the greater the chances that a diagnosis can be made early. There are now 37 tumor clinics actively functioning in upstate New York. All but 4 per cent of the population are now within 30 miles of such a clinic. New York City is a separate administrative area as regards public health.

An especially important feature of the clinic work is that of following up the cases. Otherwise patients are lost from observation. There should be close cooperation between the Welfare Department and the clinic so that indigent patients may get adequate care. One of the promising developments in the furthering of the tumor clinic program has been the organization of a Tumor Clinic Association, composed of members of the staffs of the various tumor clinics and others elected to membership by the council. This organization is interested in every type of problem that confronts tumor clinics. It recently sponsored a Cancer Teaching Day held at the School of Medicine of Syracuse University and open to all physicians of the state.

The New York State program has stimulated the formation of new tumor clinics and improved the facilities available to those already established. It has fostered postgraduate edu-

cation in cancer. Facilities for the diagnosis and treatment of cancer have been brought within easier reach of the patient. Many hospitals are better equipped to cope with cancer than ever before. The object of the program, which must be kept up in spite of war time difficulties, is to make it possible for every cancer patient, rich or poor, to obtain prompt diagnosis and adequate treatment.—*Audrey G. Morgan.*

WOLFER, JOHN A. The role of the surgeon in the tumor clinic. *Radiology*, June, 1943, 40, 549-553.

The tumor clinic must have a competent team made up of radiologist, clinician, pathologist and surgeon and they must work in close cooperation. Greater emphasis must be placed in articles and textbooks on the early symptoms of cancer. Too often the symptoms described are such late ones that treatment is hopeless. The surgeon has an important place in diagnosis by means of exploratory operation. The public is being educated to the fact that many operations that might otherwise appear useless are quite important and necessary for the diagnosis of cancerous lesions.

There are three types of lesions that must be diagnosed, first the totally exposed ones, such as tumors of the skin, second the intermediate group in which the tumors can be seen through special instruments, such as the cystoscope, the esophagoscope and the gastroscope, and third, concealed lesions in which evidence can only be obtained by roentgen study, as in intrathoracic tumors, or tumors of the liver evidenced by jaundice.

The diagnosis once made the surgeon also has an important place in treatment. In order to make the operation as safe as possible for the patient he must be familiar with the methods of correcting dehydration, anemia, acid base balance, ion concentration, etc. He must also be able to recognize and differentiate between pathologic changes as he cannot always have a pathologist at hand.—*Audrey G. Morgan.*

HOLMES, GEORGE W. A tumor clinic for patients of moderate means. *Radiology*, June, 1943, 40, 554-556.

The author describes the tumor clinics that are now being established in general hospitals, and in addition a special clinic for patients of moderate means that has been instituted at the Massachusetts General Hospital. These pa-

tients are often less well served than either the very rich or the very poor.

The principles governing the already established tumor clinic were observed and the new clinic was made a part of the older one. These patients were able to pay a moderate fee. The free clinic is held in the morning and the pay clinic in the afternoon, using the same space and equipment and lay personnel, so that expenses are reduced. Only members of the staff of the free clinic were asked to serve in the pay clinic and it is administered by the same tumor clinic committee. The earnings from the clinic, after operating costs have been deducted, are divided among the professional personnel according to the number of hours spent in the clinic. If irradiation is advised the patient is referred to the department of radiology and if surgery is required he is referred to the surgical department and may choose his surgeon. All charges for treatment are made by the department (or physician) to which the patient is referred.

The clinic was established in June, 1942, and so far has made satisfactory progress. The charge per visit has not yet been definitely established but apparently it need not be more than ten dollars for the first visit and five dollars for each subsequent visit. It is too early to draw any conclusions as to the value of the clinic but at least a beginning has been made in a new field.—*Audrey G. Morgan.*

UHLMANN, ERICH, Practical aspects of tumor clinic management. *Radiology*, June, 1943, 40, 557-564.

The author discusses the management of the tumor clinic in the Michael Reese Hospital in Chicago. Representatives from the different departments—Surgery, Gynecology, Dermatology, Eye, Ear, Nose and Throat, etc.,—are selected for consultants on the staff. They must be of associate rank or higher to insure that they will have had the necessary experience and it must be known that they have a special interest in the diagnosis and treatment of cancers in their own field. They must agree to attend the group consultations so as to become familiar with the cases under consideration. Each year four men are replaced so that there are always a certain number of men on the staff who have had experience in tumor clinic management.

In addition to the regular consultations monthly conferences are held in which particularly interesting cases are discussed—surgical

cases are presented to the surgical group, gynecological cases to the gynecological group, etc.

One of the difficult problems is the selection of a chairman for the group. Much of the success of the clinic depends on the chief. He may be a pathologist, surgeon or radiotherapist, though the author is inclined to favor the selection of a radiotherapist. The diagnostic roentgen department should be kept separate from the radiotherapeutic department. Every patient admitted to the hospital with a diagnosis of tumor must be referred to the Tumor Clinic before any treatment is given. If the referring physician or surgeon does not agree with their decision, the final decision is made by the representative in the Tumor Clinic of the department concerned. So far there has not been any special difficulty in settling differences of this kind. A fine spirit of cooperation has been shown in the Michael Reese Clinic.—*Audrey G. Morgan.*

JERRAM, C. W. S., and LANGMEAD, W. A. A method of treatment for carcinoma of breast including the forequarter. *Brit. J. Radiol.*, Jan., 1943, 15, 26-29.

A method of treating carcinoma of the breast and the adjacent tissues as a single unit is described. Treatment is given through five fields arranged around the forequarter (pectoral region, axilla and scapula) regularly as the five sides of a pentagon with the roentgen-ray beam so arranged that the volume of tissue irradiated is a five-sided pyramid whose floor is a plane surface from sternum to scapula, thus avoiding lung tissue, and whose apex lies lateral to the head of the humerus. The tissue in the pyramid is treated with nearly a uniform dosage. It is possible to give a larger total dose in a reasonable over-all time because five fields are used and because the method avoids deeper structures. For this same reason the lung is not damaged. The method is a standard one which can be reproduced at any time and gives identical cases for comparison of results.

Illustrations of the application of the method are given, a diagram showing how the fields are tilted to avoid lung tissue and the isodose curves for pentagonal distribution. A dose of about 3,000 r can be given throughout the forequarter in four weeks without general disturbance or severe skin injury.—*Audrey G. Morgan.*

DE CHOLNOKY, TIBOR. Mammary cancer in youth. *Surg., Gynec. & Obst.*, July, 1943, 77, 55-60.

Seventy-three cases of mammary cancer in patients under thirty years of age are reviewed and the following conclusions are reached:

1. Cancer of the breast in patients under thirty years of age accounts for 2 per cent of all mammary cancers.

2. Early diagnosis can be made with certainty only in the laboratory.

3. In small tumors less than 2 cm. in diameter, lymph nodes are infrequently involved and the prognosis is favorable.

4. Five year survivals in the patients operated upon were found to be 40.8 per cent; ten year survivals, 37 per cent.

5. The results of radical surgery in young women under thirty years of age are comparable to those obtained in the more advanced age groups.

6. The previously held belief that the prognosis for women under thirty years of age who have malignant tumors of the breast is fatal seems untenable.—*Mary Frances Vastine.*

NUTTALL, JOHN R. The intra-oral radium treatment of cancer of the mouth. *Brit. J. Radiol.*, Feb., 1943, 96, 45-48; March, 72-81.

A very high percentage of malignant tumors in the mouth are squamous cell carcinomas and with these tumors there is only a slight margin of safety between the tumor lethal dose and the dose that causes necrosis of normal tissue. Dosage therefore must be very accurate. The system of Paterson and Parker is a simple method of giving accurate dosage.

Modern treatment of cancer of the mouth is by radium, and dosage should be reported in international roentgens. The total number of roentgens and the overall time should be given. The optimum overall time is from seven to ten days and in this time 6,000 to 8,000 r can be given safely. For successful treatment the volume irradiated must be as small as is consistent with irradiating the whole tumor. Only one treatment is possible for squamous carcinoma and the tolerance dose must be given. If the case is curable a larger dose must be given than that necessary for palliative treatment. It is difficult to determine the boundary between curable and palliative cases and ideas on the subject change with improving technique. The best method of treating epitheliomatous glands is by block dissection. If this is impossible on account of the patient's condition, extensive treatment of the mouth cancer is not worth while. In general, probably external mould treat-

ment is preferable to implantation of needles. This depends to some extent on the site of the tumor, and a table is given showing the preferable treatment according to site.

Biopsy is valuable in diagnosis and not dangerous. Carcinoma and syphilis frequently co-exist but it is not worth while delaying treatment of the cancer to treat the syphilis as antisyphilitic drugs cause deterioration of the general condition below the limits of safety for operation.

Decayed teeth should be removed before treatment but the removal of carious teeth from irradiated tissue is dangerous and the dentist should be informed if there are any irradiated areas in the mouth when he undertakes an extraction.

A table is given showing the results of treatment in this series. Among 442 patients with cancer of the mouth of all stages treated by radium 28 per cent survived for five years. Among 140 cases in which the glands had not become involved 65 per cent survived five years or more.

Intraoral cancers may be treated by means of dental moulds or by implantation of needles. Moulds may be made of vulcanite or dental impression compound. Detailed descriptions are given of the application of moulds and the implantation of needles for tumors at different sites and illustrative roentgenograms are given.

Good anesthesia is of great importance in the implantation of needles and decreases the risk of bronchopneumonia. Adequate anesthesia can generally be maintained by the endotracheal administration of nitrous oxide and oxygen. Sodium evipan can be used if general anesthesia is contraindicated. Careful nursing is also of the greatest importance in preventing lung complications. Radon seeds are particularly useful in the treatment of small lesions in the aged or frail as they can be inserted under local or regional anesthesia. The needles can generally be removed after seven to ten days' treatment without anesthesia.

As a rule, mould techniques with moderate doses cause less damage to the tissues than implantation of needles. The safest end appearance is a slight pale atrophy which is pliable and free of marked telangiectasis. This follows a treatment of 6,500 r given in seven days to fields of medium size.—*Audrey G. Morgan.*

NOLAN, JAMES F., and QUIMBY, EDITH H.  
Dosage calculations for various combinations

of parametrial needles and intracervical tandems. *Radiology*, April, 1943, 40, 391-402.

The application of radium by the use of interstitial parametrial needles in combination with intracervical tandems has been recommended in recent years because it gives a wider distribution of radium in the pelvis and avoids the danger of necrosis from overdosage.

A number of arrangements of the needles and tandems have been used by different workers and the authors make a study of the distribution of the radiation in each one as influenced by such factors as variations in the lateral position of the needles, variations in the angulation of the needles and variations in exposure time. Of course in this work it was necessary to assume exact placing and angulation of the needles, which is not always possible in practice.

Diagrams of the various types of arrangement are given and for each type diagrams of the region to be irradiated with isodose curves in gamma roentgens. A wealth of detail is given with regard to the distribution of the radiation by these different methods but it seems that none of them is adequate for the treatment of pelvic lymph node involvement. The object of this work, however, was not to establish a definite plan of treatment but to work out the factors which influence the distribution of radiation and the ways in which they affect it so that still better plans for treatment may be devised.—*Audrey G. Morgan.*

SKINNER, EDWARD HOLMAN. An introduction to the history of carcinoma of the cervix uteri. *Radiology*, May, 1943, 40, 433-435.

The author gives a brief review of the history of carcinoma of the cervix, beginning with the Egyptian and Hippocratic era of empiricism from the earliest times to 1761 A.D. and continuing through the era of description and classification from 1761 to 1900 and that of experimental study beginning in 1900.

In 1761 Morgagni described the autopsy findings in cancer of the uterus. Peyrilhe in 1776 gave the first suggestion of extension by way of the lymphatics. Langenbeck performed one of the first vaginal hysterectomies in 1813, based on a prize-winning essay by Wrisberg in 1810. Wagner's Gebärmutterkrebs (cancer of the uterus) in 1858 described the metastatic pathways though he believed that the disease originated in connective tissue as well as epithelium. Virchow echoed this opinion in his



Cellular Pathology and Thiersch in 1865 first proved the epithelial origin of carcinoma. During this period of about one hundred years there is a history of vaginal hysterectomy. Freund described the principles of abdominal hysterectomy in 1878 but the high mortality from this method led to resolutions of condemnation by medical societies. The work of Howard Kelly and Wertheim in abdominal hysterectomy is mentioned and Wertheim's method pronounced too difficult for general use.

Irradiation was foreshadowed by Fouveau de Courmelles in 1904 when he checked menopausal bleeding by irradiation. The further progress of irradiation up to the present time is briefly reviewed and the suggestion made that vaginal hysterectomy still has a place in the treatment of carcinoma of the cervix.—*Audrey G. Morgan.*

SCHEFFEY, LEWIS C. Experiences in the treatment of carcinoma of the cervix uteri. *Radiology*, May, 1943, 40, 436-446.

The author analyzes a group of 310 patients with carcinoma of the cervix of the uterus seen on the Gynecological Ward Service of Jefferson Medical College Hospital in Philadelphia in the past sixteen years. Tables are given showing the details of the results. He speaks of five year salvage rather than five year cure because survival for five years does not by any means insure cure. He has seen recurrences as long as ten years after treatment.

Of the 310 patients seen 293 were treated. The absolute salvage rate at the time of this report was 14.3 per cent. The absolute rate means the percentage of patients seen, the relative rate the percentage of patients treated. The relative five year salvage rate including deceased patients who lived five years or longer after treatment was 23.8 per cent.

Surgery was used in the treatment of only 8 cases and surgery alone was not used in any case. From 1921 to 1931 radium was used most frequently, generally in the form of a single treatment. During this time external roentgen irradiation was used occasionally, generally after the use of radium, and most commonly in cases of recurrence. From 1931 to 1934 roentgen irradiation was used more frequently after

radium, and in far advanced cases without radium. In 1934 and 1935 the use of external roentgen irradiation before radium treatment was begun. This method has proved its value. The technique of the different methods used is described.

Catharine McFarlane and her co-workers have shown that much can be accomplished by routine pelvic examination and frequent biopsies.—*Audrey G. Morgan.*

SANTE, L. R. Further experience with pneumoperitoneum as an aid in pelvic irradiation. *Radiology*, May, 1943, 40, 447-453.

There is no doubt that larger doses of radiation should be used in the treatment of cancer of the pelvis. But there is danger of injuring the intestinal mucosa which is extremely sensitive to the action of rays. This difficulty can be obviated by placing the patient in the Trendelenburg position and introducing into the peritoneal cavity a slightly larger amount of air than that used in diagnostic pneumoperitoneum. This pushes the intestines up beyond the action of the rays. Diagrams are given showing the location of the portals and instructions given for determining the optimum direction of the roentgen-ray beam in each case. Slight compression materially increases the depth dose.

The author has used both 50 and 80 cm. distances. With 200 kv., 18 ma., 1 mm. copper effective and 1 mm. aluminum filter, half-value layer of 1.46 mm. copper, 49 r per minute is given until a dose of 200 r, measured in air, is applied to all four anterior fields and one lateral field one day. The next day the four posterior fields and the other lateral field are treated in the same way. Treatment is continued until a pronounced skin reaction occurs, which usually ends in desquamation.

The use of pneumoperitoneum for increasing the amount of radiation that can be applied to the parametrium is independent of the method used in treating the cervical lesion, whether by radium or roentgen rays given with an intravaginal cone.

Not enough patients have been treated in this way and the time since treatment was begun is too short for its value to be estimated.—*Audrey G. Morgan.*



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## ROENTGENOLOGIC APPEARANCE AND PATHOLOGY OF INTRAPULMONARY LYMPHATIC SPREAD OF METASTATIC CANCER

By H. PETER MUELLER, M.D., and RONALD C. SNIFFEN, M.D.\*  
BOSTON, MASSACHUSETTS

THE lymphatic spread of metastatic cancer in the lung presents a rather unusual roentgenologic appearance and is seen with sufficient frequency to justify greater interest than has been shown in the past. Its roentgen recognition is particularly important when the patient's early or presenting symptoms are referable to the chest only. It seems worth while, therefore, to report 10 cases which have been seen at the Massachusetts General Hospital in recent years. Seven of these cases were autopsied, while the remaining 3, who were known to have cancer, developed, while under observation, roentgenologic changes typical of lymphatic spread.

### CASE REPORTS

CASE I. (B. I. U-406494) The patient, female, aged fifty-four, developed a productive cough and pain in the region of the lower sternum five months before admission. During the last two months the sputum was occasionally blood streaked. There were no chills or fever. Despite periods of remission she became progressively worse, and three weeks before entry developed marked respiratory difficulty with asthmatic wheezing.

On admission the patient was slightly dyspneic, with a rapid pulse, and a few coarse râles

could be heard over the left chest; otherwise the lungs were clear. Under a clinical diagnosis of chronic bronchiectasis and asthma the patient was bronchoscoped. The mucosa of the right main bronchus was friable and bled easily, but these changes were believed to be inflammatory in nature. Biopsy was attempted, but no tissue could be obtained. The patient became gradually worse, with marked dyspnea, and latterly cyanosis as the most prominent clinical feature of her illness. These symptoms were not alleviated by aminophyllin, adrenaline or morphine, though an oxygen tent gave some subjective relief. Death occurred suddenly on the eleventh hospital day.

*Roentgenologic examination* of the chest showed enlargement of both hilar shadows, particularly on the right side. There was a diffuse, string-like and beaded design of increased density radiating from the hilum toward the periphery on both sides, interspersed with fine nodular areas which lay partially within and partially without the trabeculated network of increased density. The changes were evenly distributed over both lungs, but were more marked in the bases than in the upper lung fields, and more in the central than in the peripheral portions. A small amount of fluid was seen in each pleural cavity. A later roentgenogram showed evidence of destruction of the lateral portion of the ninth right rib (Fig. 1).

\* From the Departments of Radiology and Pathology, Massachusetts General Hospital, Boston, Massachusetts.

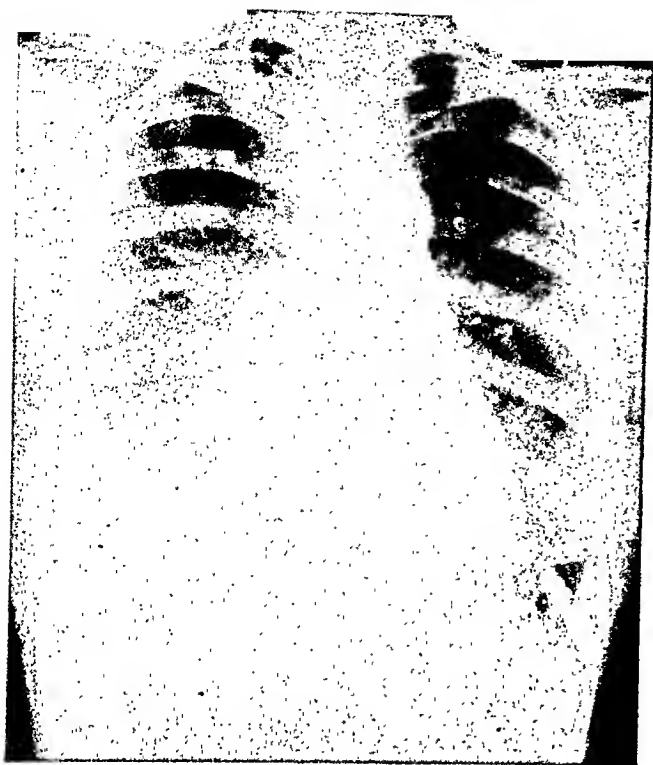


FIG. 1. Case I.

The original diagnosis was bronchiectasis and fibrosis.

*Anatomic Diagnosis.* Carcinoma of the pancreas with metastases to lungs, bronchial and retroperitoneal lymph nodes; bronchiectasis.

At postmortem, the origin of the primary tumor was not immediately obvious, but the pancreas, which was of normal weight and size, contained scattered granular nodules, which averaged 1 cm. in diameter, and its normal lobular architecture had been destroyed. The left pleural cavity contained a liter of clear fluid and was free from adhesions. The right pleural cavity was obliterated by fibrous adhesions except for a 200 cc. collection of cloudy fluid above the diaphragm posteriorly. The lymphatics of the visceral pleura of each lung stood out as a prominent gray lacework and 1 to 2 mm. gray nodules had formed at the angles of this lacework. On section there was a moderate diffuse bronchiectasis with generalized congestion and edema. Throughout the parenchyma of each lung the lymphatics were also very prominent and beneath the mucosa of the bronchi were minute gray nodules. The bronchial and mediastinal lymph nodes had been invaded by tumor.

Microscopically the primary tumor was found to be an anaplastic carcinoma arising in the pancreas. The metastatic spread in the lungs was almost exclusively confined to the lymphatics of the pleura, septa, bronchial walls and

perivascular lymph channels (Fig. 2). Tumor cells were lying in the peribronchial lymphatics as far out as the respiratory bronchioles. In addition, there were mild bronchiectatic changes and small areas of pneumonia and fibrosis. No blood vessel changes were detected, which could be considered unusual for the patient's age.

**CASE II.** (A. A. U-395930) Approximately one year before admission the patient, male, aged forty-six, developed anorexia and a sense of fullness in the epigastrium and began to lose weight. Four weeks before entry his symptoms became more severe and in addition he developed a cough, which was more marked at night, and productive of small amounts of white sputum without blood. One week before admission dyspnea and tachycardia were noted, and he perspired profusely without having chills or fever.

On admission, the patient was in moderate respiratory distress with a rate of 35, and moderate cyanosis was noted. The pulse was 100, the temperature 99° F. Examination of his chest showed a scattering of fine expiratory wheezes, a few coarse moist râles over both bases posteriorly, and a friction rub over the right base posteriorly. The abdomen was essentially normal. Biopsy of an enlarged cervical lymph node showed metastatic adenocarcinoma; the stomach was believed to be the probable seat of the primary tumor. The patient died twelve days after admission, at which time dyspnea, tachycardia, cyanosis and generalized pulmonary edema were the significant physical findings.



FIG. 2. Case I. A dilated perivascular lymphatic filled with tumor cells.

# Lymphatic Spread of Metastatic Cancer

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*Roentgenograms* of the chest showed a rather marked, fine miliary, nodular and linear process involving both lungs in an uneven design of trabeculation which extended from enlarged hilar shadows toward the periphery and was most marked in the mid portions of the lungs, the apical and peripheral portions being least involved. Scattered within the miliary design there were a few larger areas of increased density, approximately 0.5 cm. in diameter (Fig. 3).

*Anatomic Diagnosis.* Carcinoma of the stomach with extension to the esophagus and metastases to the retroperitoneal, mediastinal, bronchial and cervical lymph nodes, kidney, lung and right adrenal.

At autopsy an annular tumor was found in the stomach arising in the region of the esophagogastric junction. Each pleural cavity contained approximately 200 cc. of cloudy fluid. The lungs were voluminous and the pleural surface on all aspects was studded with small gray nodules. The left apex was firm and airless, and here the pleura was covered with a fibrinous exudate. On section, the parenchyma was crepitant but somewhat edematous, and the consolidated area in the left apex had the appearance of pneumonia. In addition, many small gray nodules were scattered throughout the parenchyma and these seemed to be localized around the bronchi and blood vessels. There was an acute tracheobronchitis, and the mediastinal lymph nodes contained obvious metastatic tumor.

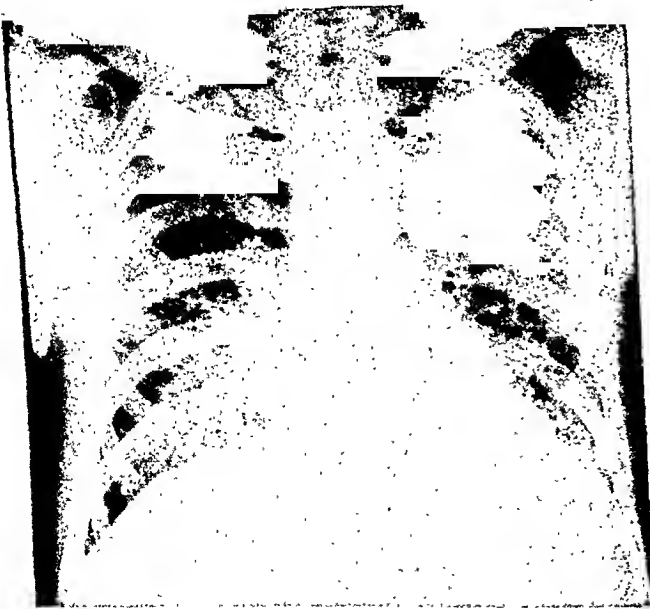


FIG. 3. Case II.

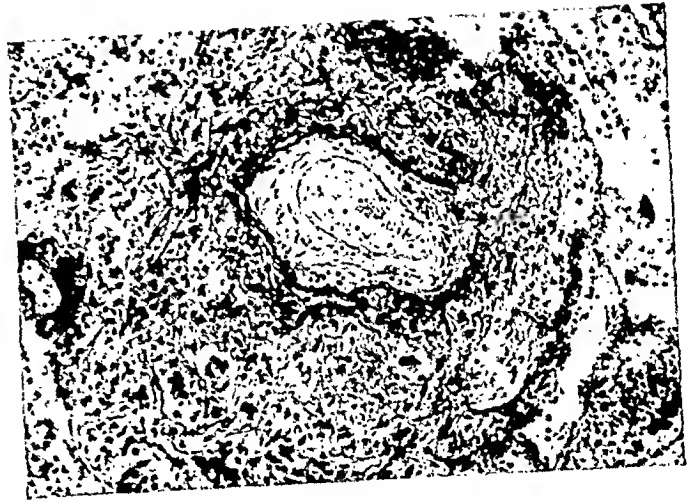


FIG. 4. Case II. A pulmonary artery showing concentric intimal thickening, a mild chronic inflammatory infiltration and tumor cells in the media and adventitia.

Microscopically, the primary tumor in the stomach proved to be a poorly differentiated adenocarcinoma with minimum gland formation. The lungs showed a patchy pneumonia and edema, but the most striking finding was the presence of poorly differentiated tumor cells lying almost exclusively within the dilated lymphatics of the bronchi, arteries and veins, and in some instances a sleeve of tumor cells had formed around these structures. Only minute clumps of tumor cells could be found in the parenchyma unrelated to the lymphatics. In addition, there were pronounced vascular changes, predominantly in the medium sized arteries and arterioles. The lumina of many contained tumor emboli in which the central cells were usually necrotic. Thrombotic material was often associated with these emboli thus leading to complete occlusion, and occasionally organization from the adjacent intima was well advanced. In a great many arteries the intima was thickened by a loose fibrous proliferation which was usually concentric, but occasionally took the form of a bud projecting into the lumen. Some of the smaller arteries were almost obliterated by this process. Tumor cells were sometimes incorporated in these segments of intimal thickening. The significance of this fact could not be determined; the matter will be discussed later. The media in many arteries contained small nests of tumor cells, while the adventitia with its tumor-filled lymphatics showed a dense fibrous thickening reminding one of the stromal reaction in the stomach wall. In most instances where tumor cells were present all layers of the artery showed a mild or severe infiltration of chronic inflammatory cells

(Fig. 4). Compression of arteries and veins by dilated tumor filled lymphatics was particularly noticeable.

**CASE III.** (M. M. U-101107) The patient, male, aged sixty, came to the hospital because of severe epigastric pain and vomiting which had been growing worse for the past four months. For five weeks the pain had been aggravated by deep breathing. Two days before entry he developed a cough, productive of thick yellow, frothy sputum, and dyspnea.

right lung—coarse nodularity connected by a network of linear markings. The process in the right lung had also become more extensive, and there was an area of homogeneous density in the central portion near the hilum which had not been present a week before. The process was more marked in the central and apical portions than in the lower lung fields (Fig. 5).

*Anatomic Diagnosis.* Carcinoma of the cardia of the stomach with perforation into the peritoneal cavity, with extension to the esophagus and pancreas, and with metastases to the liver,

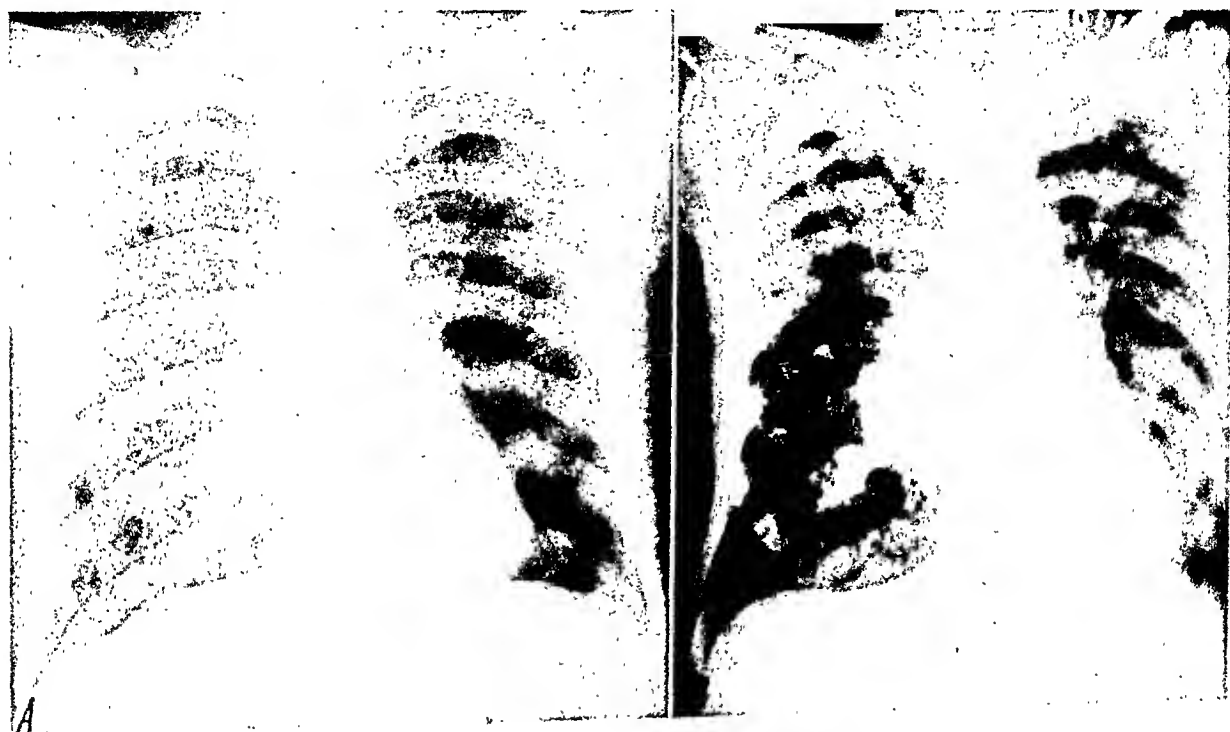


FIG. 5. Case III. B taken one week after A.

On examination, a few crackling râles were heard throughout the right lung, and the breath sounds were somewhat distant on the left. The pulse was always above 100 and at one point reached 160. The patient failed rapidly; his respiratory signs increased (râles and wheezes being present throughout the chest). Death occurred ten days after admission.

*Roentgenologic examination* showed a gross nodular involvement of the right lung and a network of irregular increased density which was evenly distributed over the entire lung, becoming more marked near the hilum. The left lung was less involved than the right, containing only a faint suggestion of a similar design. Re-examination one week later showed the change in the left lung to have increased so that it presented a picture similar to that in the

right adrenal, lungs, heart and regional and distal lymph nodes; acute fibrinous peritonitis.

Postmortem examination revealed a large ulcerating carcinoma, centered on the lesser curvature of the stomach. Perforation had occurred through the base of the tumor at two points. The pleural cavities each contained 120 cc. of clear fluid. The pleura of each lung was grossly normal except for many pinhead-sized subpleural nodules scattered over all surfaces. Some of these nodules, however, measured as much as 1 cm. in diameter. Section of the left lung showed a gross pneumonia in the lower half of the upper lobe with congestion and edema in the remaining parenchyma. The right lung was congested and edematous without obvious pneumonic consolidation. In each lung a coat of firm gray tissue surrounded the cut surface of the



smaller bronchi. The trachea and opened bronchi seemed normal. The bronchial and mediastinal lymph nodes were enlarged to 2 cm. in diameter and contained gross tumor.

Microscopically, the appearance of the primary tumor in the stomach was one of extreme anaplasia and pleomorphism without gland formation. As anticipated from the gross appearance, the lungs showed innumerable collections of tumor cells throughout the parenchyma. These were situated primarily in the lymphatics of the pleura, interlobular septa, bronchial walls and around blood vessels. An occasional metastatic nodule was so large that this relationship was destroyed, and in a few fields groups of tumor cells lay free in alveolar spaces without causing tissue destruction. The lumina of a number of small and medium-sized arteries contained tumor cells which were often embedded in thrombotic material. This had led to occlusion of the smaller vessels, but in the larger arteries emboli were found clinging to the intima and here organization was well advanced, leaving a background of young fibroblasts in which tumor cells were sprinkled. The endothelium of the intima was resurfacing these buds of tissue. An occasional artery showed concentric tumor cell infiltration of all three coats with consequent marked intimal thickening leaving a central lumen (Fig. 6). In some fields alveolar capillaries had been flooded with tumor cells. Pneumonic consolidation was found in the lower half of the left upper lobe and there was a generalized but patchy edema.

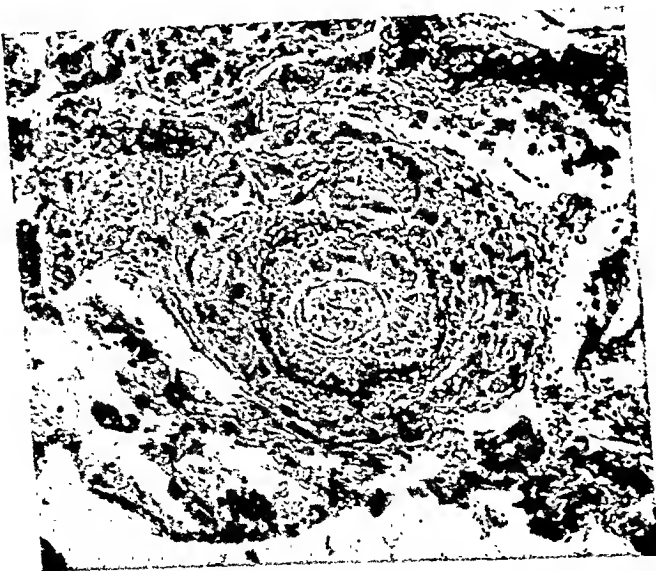


FIG. 6. Case III. A pulmonary artery with intimal thickening and tumor cell infiltration of all coats.

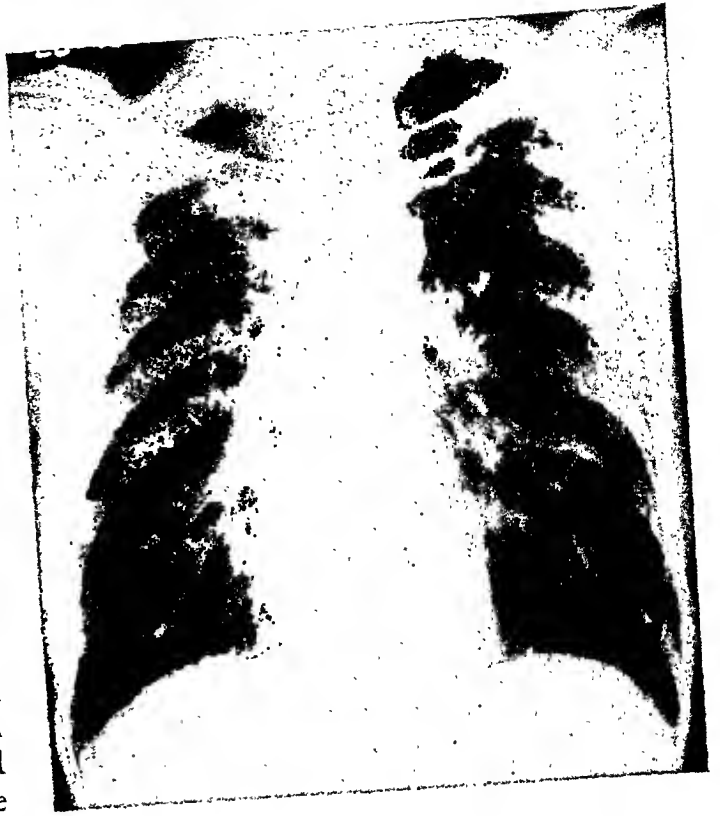


FIG. 7. Case IV.

CASE IV. (P. C. U-390800) The patient was a man, aged sixty-three, who had been well until three weeks prior to admission. He entered the hospital complaining of severe headache. A deep chest cough productive of a half cup of foul sputum daily subsided after five days, leaving soreness in the lower dorsal spine and epigastrium. The pain was not related to eating but was aggravated by coughing. On admission the patient was cachectic and in severe pain, located chiefly in his back. Physical examination of the chest was negative. Biopsy of an enlarged supraclavicular node revealed metastatic adenocarcinoma. The patient retrogressed rapidly and died nine days after admission.

*Roentgenograms* of the chest showed a slight, ill-defined enlargement of the hilar shadows and numerous fine miliary areas of increased density throughout both lung fields which were connected with each other by a fine, irregular network of linear markings, most pronounced in the central and lower portions of both lungs, but which also extended to the upper lungs and apices bilaterally (Fig. 7).

*Anatomic Diagnosis.* Scirrhus carcinoma of the stomach with metastases to the regional and supraclavicular lymph nodes, adrenals, lungs, liver and vertebral marrow.

At autopsy, a scirrhus carcinoma involved the entire circumference of the body of the stomach. The wall was thickened to 1 cm., the



serosal lymphatics were outlined by the tumor which they contained, and the lymph nodes along the lesser curvature were involved. Each pleural cavity contained approximately 350 cc. of serosanguineous fluid, and a few fine fibrous adhesions were found at each apex and base. The visceral pleura of both lungs was smooth and glistening, but the interlobular lymphatics

some of these contained tumor cells at the level of section. Occasionally atypical cells were found in the capillaries of the alveolar walls.

**CASE V.** (C. M. U-397203) A man, aged seventy-three, entered the hospital complaining of constipation and abdominal pain and distention of three weeks' duration. The onset of his symptoms had coincided with the development of a "cold" characterized by a cough productive of foamy white sputum. For the past two days he had not defecated. A laparotomy with transverse colostomy was performed and metastatic tumor was found throughout the peritoneal cavity. Subsequently he developed tachycardia, rapid noisy respirations with cyanosis and dullness to percussion over the right lower chest. In spite of oxygen therapy his respiratory embarrassment continued until death on the tenth postoperative day.

*Roentgen examination* of the chest showed an irregular pattern of increased density with a linear design extending throughout both lungs from the hilum to the periphery, through which numerous small, irregular areas of increased density were scattered. These changes involved the lower portions of the lungs more than the apical regions. A small amount of fluid was present in each pleural sinus (Fig. 8).

*Anatomic Diagnosis.* Carcinoma of the body of the pancreas with metastases to the peritoneum, mesenteric and retroperitoneal lymph nodes, pleura, lungs, pericardium and liver.

At autopsy, the primary tumor was found in the body of the pancreas. It measured approximately 7 cm. in diameter and had produced atrophy of the parenchyma distal to it. The pleural cavities each contained roughly 250 cc. of fluid, and there were a few fibrous adhesions at the right apex. The outstanding gross finding in the lungs, apart from a moderate edema, was the presence of innumerable 2 to 4 mm. gray nodules, situated beneath the pleura and in immediate relation to the bronchi. In the left lower lobe there was an almost spherical tumor mass, 3 cm. in diameter. The trachea and bronchi showed slight mucosal congestion.

Microscopically, the pancreatic tumor was a fairly well differentiated adenocarcinoma. Sections taken from tissue in the immediate neighborhood showed carcinoma in the interlobular lymphatics. The metastatic tumor in the lung was also entirely located in the pleural, bronchial, peribronchovascular and perivascular

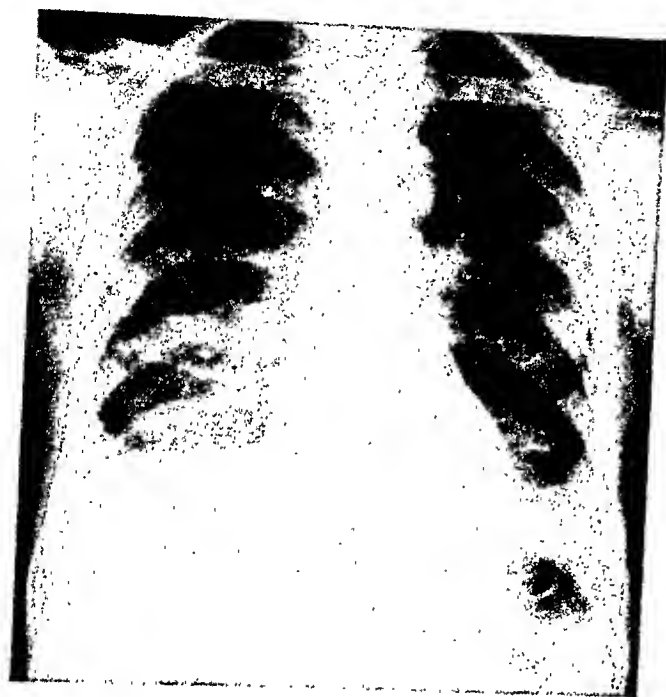


FIG. 8. Case v.

stood out as gray lines and along their course there were firm gray nodules, measuring as much as 1 cm. in diameter. On section, there was moderate congestion and edema, and the parenchyma was marred by prominent fibrous trabeculations. The trachea and bronchi were acutely inflamed and both bronchial and mediastinal lymph nodes contained tumor.

Microscopically, the primary tumor in the stomach was typically scirrhus in type with large numbers of anaplastic cells lying singly and in groups in a dense fibrous stroma. The tumor cells had completely destroyed the mucosa and infiltrated all layers of the organ. In the serosa they were found to lie predominantly in the perivascular lymphatic channels. All sections of the lung showed essentially the same microscopic picture. The metastatic tumor cells lay entirely within the lymphatics of the pleura, bronchial walls and around blood vessels. The intervening parenchyma was free from tumor and showed an early bronchopneumonia with mild congestion and edema. Many small pulmonary arteries were occluded by thrombi and

lymphatics, as well as the interlobular septa. The tumor cells retained their ability to form glands and in some fields were producing a colloid substance. In general, there was an acute bronchitis with minimal spread of the inflammation into the surrounding parenchyma. No blood vessel change could be detected apart from a few thrombosed arteries. No sections were taken of the mediastinal lymph nodes.

**CASE VI.** (M. H. U-400685) The patient, female, aged fifty-nine, was under observation for eighteen months because of epidermoid carcinoma of the cervix. One month before death she coughed up a little blood and developed dyspnea and a dry hacking cough, both of which became increasingly severe. Fluid accumulated repeatedly in the left chest after tapping. On admission the patient was in extreme respiratory distress and slightly cyanotic with Cheyne-Stokes respiration. The pulse rate ranged from 100 to 150. A left pleural tap in the hospital was not followed by a reaccumulation of fluid, but the patient became more dyspneic, weaker, and died four days later.

*Roentgenologic examination* of the chest showed a rather diffuse, increased density involving the right lower lung field. A fine network of rather dense and broad trabeculation was visualized in the upper lung field where the lung appeared to be fairly well aerated. The left lung was clear (Fig. 9).

*Anatomic Diagnosis.* Epidermoid carcinoma of the cervix with adnexal extension, and with metastases to the lungs and pleura.

Postmortem examination of the cervix showed that it had been replaced by tumor which extended into the surrounding soft tissue. The left pleural cavity was partially obliterated by fibrinous adhesions in which there were many small granular tumor nodules. The right pleural cavity showed a fibrinous exudate over the posterior and medial surfaces. On section, the right lung was not remarkable apart from moderate edema. The left lung showed tumor nodules not only over its pleural surface but throughout the parenchyma. These nodules varied from 1 to 15 mm. in diameter. Their particular distribution was not noted. The bronchial lymph nodes on the left contained obvious metastatic tumor and several of the mediastinal nodes were also involved.

Microscopically, the cervical tumor was an undifferentiated epidermoid carcinoma (Grade 4). Its pulmonary metastases in the left lung

were predominantly lymphatic so that small and large groups of atypical cells were found in the bronchial walls and around blood vessels. In a few fields the intervening parenchyma contained masses of tumor cells which had filtered into the alveolar spaces in a manner reminiscent of inflammatory cells in pneumonia; that is, without producing necrosis of alveolar walls. In



FIG. 9. Case vi.

addition, there was an early bronchopneumonia.

**CASE VII.** (L. T. U-417778) A man, aged forty-one, came to the hospital complaining of a productive cough, chest pain and increasing dyspnea of three months' duration. Physical examination showed fluid and consolidation in the right chest, a pulse averaging 110, clubbing of the fingers, cyanosis with a malar flush, generalized lymphadenopathy, enlargement of the liver and edema to the sacrum. Bronchoscopic biopsy revealed an undifferentiated carcinoma. Repeated right chest taps were performed as blood-stained pleural fluid rapidly accumulated. Each time less fluid could be withdrawn until finally only a few centimeters were obtained. Still his cyanosis and dyspnea increased. Later the sputum became blood streaked. The patient died nineteen days after admission.

*Roentgenograms* of the chest showed a moderate amount of fluid in the right pleural cavity. The right hilum appeared to be enlarged, and from it extended a string-like design of increased density, which involved the entire right lung but was more marked in its downward

than upward radiation. The trabeculated area extended to the periphery and was of uneven thickness and irregular pattern (Fig. 10).

*Anatomic Diagnosis.* Colloid carcinoma of the right lung with metastases to the pectoral region, mediastinal lymph nodes, pericardium, heart, pulmonary artery, aorta and adrenals.

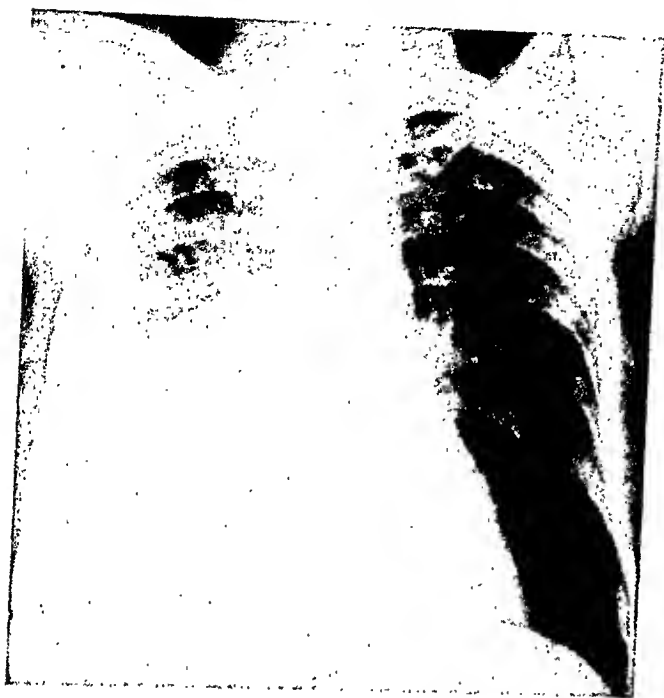


FIG. 10. Case VII.

At postmortem, it was difficult to determine the exact point of origin of the tumor in the lung. In the mucosa of the right main bronchus there were many pinhead-sized, firm nodules. The apex of this lung was covered with a greatly thickened pleural layer of cartilaginous consistency, while the rest of the pleura was roughened by a fibrinous exudate. Throughout the entire parenchyma of this lung the bronchi and blood vessels were surrounded by cuffs of gray, firm tissue, and many small nodules were found in the mucosa of the larger bronchi. The left lung showed collapse and edema in its lower lobe. The bronchial and mediastinal lymph nodes were almost completely replaced by tumor. Each pleural cavity contained approximately 500 cc. of blood-tinged fluid and the right was obliterated by fibrinous adhesions.

Microscopically, the tumor in the right lung was extremely anaplastic and for the most part the cells appeared in small groups without definite arrangement, although occasionally vague acini seemed to be forming. Many of the cells contained a colloid substance within their cytoplasm. Most of the sections showed extensive

infiltration by tumor to which there was a pronounced fibroblastic response. However, in those areas which were relatively uninvolved, groups of tumor cells were found to be confined within the lymphatics of the bronchi and blood vessels. Furthermore, there were profound vascular changes similar to those described in Case II. In general, the parenchyma of the lung showed a moderate intra-alveolar hemorrhage with many pigmented phagocytes and a mild bronchopneumonia. The left lung was essentially normal. The spleen and kidneys were congested and the liver, which weighed 2,100 grams, showed central congestion and necrosis. These findings undoubtedly indicate some degree of right heart failure.

CASE VIII. (G. M. U-207642) A woman, aged fifty-nine, was treated for a year with radium and roentgen therapy because of a carcinoma of the cervix proved by biopsy. Three months prior to death she developed a chronic cough which gradually increased in severity. Shortly before death there was moderate respiratory

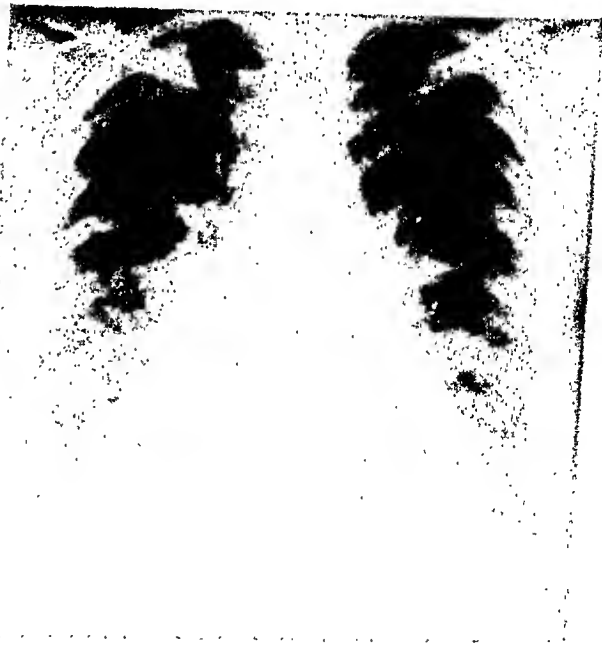


FIG. 11. Case VIII.

embarrassment. During the period of observation the roentgen appearance of the lung changed from a questionable lesion to the characteristic appearance of lymphatic spread of carcinoma. The first roentgenogram of the chest showed a questionable increase in the hilar markings throughout both lungs. Four months three weeks later showed complete obliteration of both hilar shadows from which arose

regular, string-like design of increased density radiated downward and toward the periphery, and to a lesser extent upward. The regularity of the trabeculated network was broken up by numerous more nodular areas (Fig. 11).

The patient died at home and no autopsy was obtained.

**CASE IX.** (C. B. HH 41-1060) A man, aged sixty-two, was treated for carcinoma of the tongue with very extensive metastatic involvement of the maxillary and cervical lymph nodes. While he was under observation, the characteristic appearance of lymphatic spread of cancer became evident on the roentgenograms of the chest. A diffuse uneven linear area of increased density, radiating from the hilar shadows toward the lung fields, most marked in the central and basal portions, was present at subsequent examinations. Between the linear markings a fine beaded network was visible due to numerous more nodular areas of increased density which appeared to fall within the primary pattern. A small amount of fluid was pres-

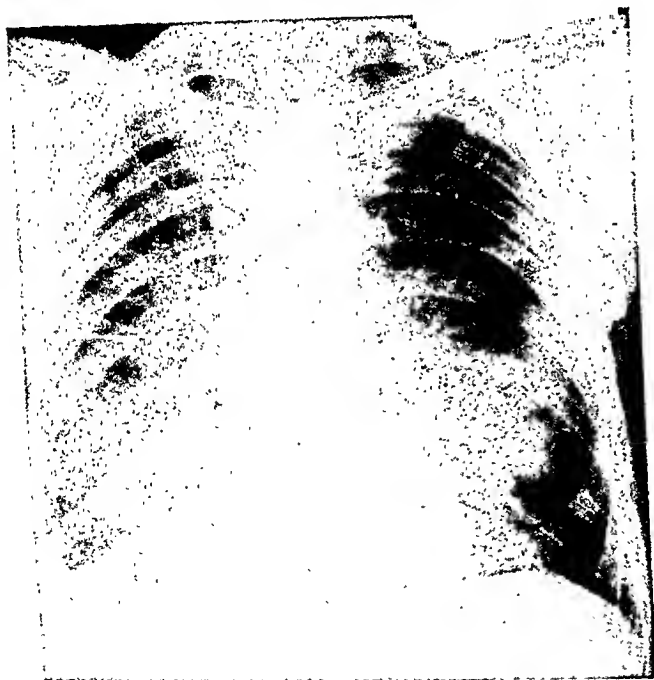


FIG. 12. Case IX.

ent in the right pleural cavity. At a final examination ten days later the process had increased in extent and intensity (Fig. 12).

The patient failed rapidly. A paroxysmal cough and respiratory embarrassment were marked for the two weeks before death, which occurred at home. No autopsy was obtained.

**CASE X.** (H. N. U-392861) A man, aged

thirty-one, was under treatment for melanotic sarcoma of the left arm with metastasis to the axilla. Four months before death the tumor was excised from the arm and the diagnosis confirmed microscopically. At this time there were no pulmonary symptoms and the roentgenogram of the chest showed a barely noticeable in-

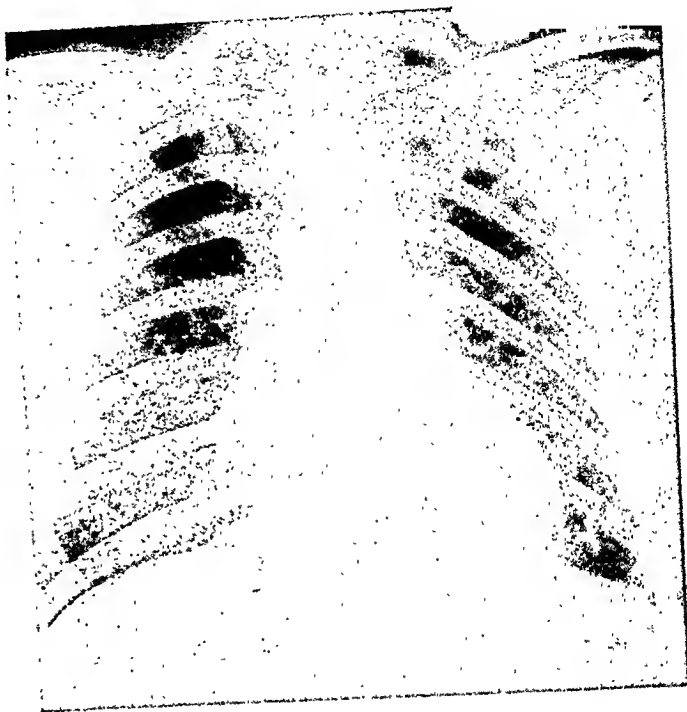


FIG. 13. Case X.

crease in the pulmonary markings with a possible suggestion of a nodular process involving both lungs homogeneously.

Three weeks later, an axillary dissection was carried out and the nodes were found to contain tumor. Roentgen examination showed a marked homogeneous miliary process in both lungs, due to irregular tiny nodules connected with each other by uneven linear areas of increased density (Fig. 13).

One month later the patient developed pain in the right chest, cough and fatigue. Roentgen examination disclosed further increase in the process. The patient died at home two months afterwards. No autopsy was obtained.

#### DISCUSSION

From these case reports it is evident that the roentgenologic appearance of lymphatic spread of carcinoma, although often difficult to interpret, is fairly characteristic. The best and most complete description is still that given by Assmann.<sup>1</sup> Roentgenograms show a diffuse, string-like formation

of increased density, which radiates from the hilum toward the periphery. The trabeculae break up into a fine network, scattered through which are numerous miliary nodules that usually correspond to the point of intersection of the trabeculae, or represent fine lymph vessels which are hit edge-on by the roentgen rays. The design in most cases is more marked in the central and basal portions of the lung, but it extends into the periphery and also into the upper portions. In only 1 of our cases (Case III, in the final stage) was the upper lung field more involved than the lower. Occasionally the changes are more marked on one side, or are unilateral. Often slightly larger nodules, due to large metastatic masses, are scattered between the linear markings and the fine miliary nodules. In most instances enlargement of the hilar nodes is obvious on the roentgenogram. Occasionally a small amount of fluid may be present in the pleural cavities.

In brief, the roentgen appearance is characterized primarily by a prominent linear trabecular network of increased density beneath which fine miliary nodules are visualized less distinctly. This is entirely different from the more common types of metastases which appear either as nodular or diffuse densities.

Lymphatic spread of cancer throughout the lungs represents the end-result of a carcinoma which usually originates in a distant organ but occasionally within the lung itself. In most instances, both lungs are evenly involved, but when the condition arises from an intrapulmonary tumor, or occasionally under other conditions, the lymphatic spread may occur on one side only or predominantly on one side. Anatomically there are two lymphatic systems within the lungs, one the deep intrapulmonary system and the other a more superficial pleural system, which drains the pleura and the most peripheral portion of the lungs. The intrapulmonary system extends through the bronchial and perivascular tissue and drains into the hilar lymph nodes. The pleural system runs in the con-

nective tissue of the pleura and the interlobar septa, and also drains into the hilar lymph nodes, or to the thoracic duct. A sparse anastomotic circulation exists between these two systems at the periphery of the lungs.<sup>11</sup> It is predominantly involvement of the deeper intrapulmonary system which leads to the characteristic appearance of intrapulmonary lymphatic spread.

Two of our cases (Cases VI and VII) showed the process confined almost entirely to one side of the chest. In Case VII the primary tumor was a bronchiogenic carcinoma which led to a diffuse spread throughout the entire right lung. In Case VI, the chest examination disclosed changes in the right lung only, the lymphatics being invaded by metastatic tumor with unilateral involvement of the bronchial lymph nodes. The left side was practically free of disease. In another case (Case III) marked involvement of the right lung preceded the involvement of the left lung. The first roentgenogram showed the left lung to be practically free of disease, while re-examination one week later disclosed that the process had spread diffusely and evenly over both lungs.

The roentgen diagnosis of lymphatic spread of cancer is often difficult unless it is suggested by a known primary tumor or proved metastatic disease. In some cases, characteristic roentgenologic findings appear before the clinical symptoms; in a few instances, clinical signs and typical roentgen pulmonary changes are present with no suggestion of malignant disease elsewhere. Case I illustrates this latter observation. In this patient the diagnosis was not established before death despite the characteristic roentgenogram, which was interpreted as bronchiectasis and fibrosis because nothing pointed toward malignant disease. Only at autopsy was the small, silent carcinoma of the pancreas found, with widespread metastases and marked invasion of the pulmonary lymphatics.

With reference to the pathology of the cases, it might be well to say at the outset that nothing new or startling has been

found. Beginning with Andral<sup>2</sup> in 1829 a considerable number of reports have accumulated in the literature. These are predominantly of European origin and cover the subject rather thoroughly. It is not amiss, however, to emphasize certain points.

Case reports indicate that approximately 70 per cent of the cancers that give rise to pulmonary lymphatic spread have originated in the stomach. The remainder have arisen in the lung, breast, prostate, colon, gallbladder, tongue, kidney and ovary.<sup>12,14,16</sup> In our group of 10 cases, the primary tumor was situated as follows: 3 in the stomach, 2 in the pancreas, 2 in the cervix, 1 in a bronchus, 1 in the tongue, and 1, a melanotic sarcoma, first appearing in the left arm. With one exception the tumors were undifferentiated. Diffuse pulmonary lymphatic metastasis occurs about twice as often in men as in women, undoubtedly because of the high incidence of cancer of the stomach in the former. In this series, the same ratio obtained, 7 occurring in men and 3 in women.

In general, this diffuse infiltrative form of cancer occurs in younger persons than the average for cancer, the majority of cases occurring in the two decades thirty to forty-nine. In our group, the ages ranged from forty-one to seventy-three, with an average of fifty-nine years, which falls in the expected cancer age.

It is intriguing to speculate how and why these tumors spread to the lung and elsewhere in this particular fashion. It will be noticed from this report and others that an almost constant finding is involvement of the hilar lymph nodes, and furthermore, that there is a tendency to widespread lymph node involvement. If sections are taken from tissue adjacent to the tumor, lymphatic permeation is a more outstanding feature than in the average malignant tumor, and the perineurial lymphatics are frequently involved. Thus, there is a general preference for lymphatics. If one assumes that hilar lymph node involvement is a constant feature, cancer cells must

reach these nodes by way of their afferent or efferent lymphatics. If dissemination is via the afferent route, the lungs must be involved first. This supposition would necessitate primary blood spread or pleural metastasis with final invasion of the pulmonary lymphatics; this seems highly unlikely and unnecessarily complicated. The alternative route is favored by most authors,<sup>9,12,16,17,18</sup> that is, retrograde permeation of the pulmonary lymphatics following involvement of the higher lymph nodes. This theory seems reasonable because the lymphatic circulation ebbs and flows sluggishly with little pressure. When one path of drainage is blocked, the flow is reversed and the fluid is carried away along neighboring channels. A similar phenomenon occurs in sarcoidosis in which hilar lymph node enlargement seems to be the primary manifestation. If the lung parenchyma becomes involved, the lesions develop as a fan-shaped radiation from the hilum.<sup>5,6</sup>

The pathologic appearance in the lungs of the autopsied cases exhibited the constant picture of lymphatic permeation with variation in the form of minor or major vascular change. On gross examination the lungs were voluminous, while the pleura was smooth and seldom marred by a fibrinous exudate. The pulmonary lobules were outlined by the gray lines of dilated lymphatics which had formed a network suggesting a mosaic pattern. Nodules often formed at the angles of this network. The cut surfaces were remarkable in that each bronchus or blood vessel seemed to be surrounded by a gray cuff of tumor, and here again the lymphatics were prominent. In general the parenchyma was edematous. The hilar lymph nodes contained gross tumor in all but one case (no microscopic sections were taken in this case), and in all instances there was a variable quantity of pleural fluid.

Microscopic sections showed that the lymphatics throughout the entire lung were dilated and contained groups of metastatic tumor cells, some of which were necrotic. They were found in the lymphatics of the



pleura, the thickened interlobular septa, around blood vessels of all sizes and throughout the bronchial walls. Invasion of the bronchial mucosa had occurred at various points in all cases. In each case, also, a very few tumor cells lay scattered in the alveoli, and in one instance they had filled these spaces over a few low power fields in the manner of inflammatory cells in pneumonia without as yet producing tissue destruction.

Widespread and profound arterial damage had taken place in Cases II, III and VII. The changes have not been explained satisfactorily. The tumor cells in the lymphatics of the adventitia seemed to have excited an intense fibroblastic reaction so that the coat was greatly thickened. The media and intima often contained small nests of tumor cells. This invasion by tumor cells was frequently accompanied by a lymphocytic infiltration. In many fields the intima of the small arteries and arterioles was thickened by a layer of acellular fibrous tissue in which the fibers were widely separated, presumably by fluid. This was either concentric or plaque-like, and occurred in the presence or absence of tumor cells in the coat itself. Furthermore, tumor cell emboli, usually associated with thrombotic material, were present throughout the arterial system. In the small radicles this had produced occlusion, and in some instances partial or complete organization with recanalization had occurred. In the large arteries, there was no occlusion, but a few vessels were found where the tumor cells and thrombotic material were adherent to the intima from which organization and endothelialization of the mass were taking place. Tumor cells had also reached the alveolar capillaries. In Case IV, tumor emboli were present in the vessels without other arterial change, and in Case V, arterial thrombosis was found without tumor emboli or arterial change. The pulmonary veins, on the other hand, contained neither thrombi nor tumor emboli, although the surrounding lymphatics were dilated and partially filled with tumor cells. Occasion-

ally, however, fibrous intimal thickening and tumor cell invasion of the outer layers of the venous wall were present. Both arteries and veins were often compressed by the surrounding dilated lymphatics.

The reason for the arterial changes, which were first described by Girode<sup>7</sup> in 1889, is not entirely clear. Wu,<sup>13</sup> in a beautifully illustrated paper, states his belief that the intravascular deposition of carcinoma plays an important part in the genesis of the obliterative changes and that the edematous thickening of the arterioles is a local manifestation of the general interstitial edema of the lung following obstruction. Greenspan<sup>8</sup> is of the opinion that the same fibroplastic factor that is responsible for the extensive increase in the perivascular connective tissue might also be responsible for the intimal hyperplasia. From the present observations, we are inclined to believe that (1) tumor cell embolism by way of the blood stream is the sole factor leading to the arterial occlusion (if other factors are present, thrombosis should also occur in the veins); (2) the adventitial thickening is initiated by the presence of tumor cells; (3) if the intimal thickening is a local manifestation of edema, it should occur equally in the arteries and veins and should appear more often than it does in lymphangitic carcinosis. In our series, intimal thickening occurred only in those cases which showed a combination of tumor cell invasion of the blood vessel walls and thrombosis of the arterial lumina. We believe that the two must be related.

The major symptoms in lymphatic carcinosis of the lung occur with great regularity and contrast sharply in their severity with the negligible physical signs. In the various cases reported throughout the years the paucity of physical findings in the lungs has been emphasized again and again, and the present report does not refute the reiteration. The pulmonary symptoms, however, often overshadow those which arise from the primary tumor, usually throughout the entire, brief course of the patient's illness. The important clinical findings are dys-



nea, cyanosis, a productive cough and rapid cachexia. Dyspnea occurred in 6 of the 7 autopsied cases, and in these patients it was an outstanding feature of the terminal picture and did not respond to the usual palliative measures. Cyanosis was present in 4 patients, and all the patients had varying amounts of sputum. When the clinical and pathologic findings were suitably tabulated in each case it seemed that no single anatomic abnormality could account for any given symptom. The variety and severity of the pathologic findings seem to explain adequately the clinical manifestations. All the patients had a productive cough and in 3 of them the sputum was blood streaked. This is accounted for by the destruction of the bronchial mucosa by invading tumor cells, a phenomenon encountered in all the lungs examined. King and Castleman<sup>10</sup> studied 109 cases of pulmonary metastatic tumor and found that 20 (18.5 per cent) showed bronchial invasion either by direct extension from a neighboring tumor or by lymphatic spread. Four of the 20 patients raised blood-streaked sputum; 9 had no pulmonary symptoms.

It is interesting that a certain number of patients with lymphangitic carcinosis die with definite clinical signs of right heart failure, and at autopsy the right ventricle shows hypertrophy and dilatation. Two of the more recent reports concerning this mode of death are those of Greenspan<sup>8</sup> and Brill and Robertson.<sup>4</sup> Arterial changes were present in roughly half of the cases reported in the literature. In the clinical records of our patients, heart failure was not mentioned, though all but Case IV had tachycardia (between 120 and 130), and in Case VII there was liver enlargement and peripheral edema. No electrocardiographic tracings were made. None of the patients examined was said to have had right ventricular hypertrophy, but unfortunately this abnormality is overlooked rather easily. One case\* with cardiac change has been encountered in this laboratory, but it was

not included in the present series because pleural fluid obscured the roentgen pattern. This patient had cancer of the stomach with lymphatic spread to the lungs without endarteritic changes in the pulmonary vessels. There were clinical signs of right-sided heart failure and right axis deviation in the electrocardiographic recording.

Only one patient (Case IV) showed significant blood changes, and these were anemia and purpura. Furthermore, this patient was the only one in whom bone marrow metastases were found. Jarcho,<sup>9</sup> in 1936, reviewed the subject of diffuse infiltrative carcinoma. From his study he concluded, not without good reason, that lymphangitic carcinoma of the lung and metastatic carcinoma of the bone marrow associated with thrombopenia and purpura tend to occur in the same type of case and in the same individual. His patients were predominantly young adults with a scirrhous or diffusely infiltrating gastric carcinoma which was often silent clinically, and whose illness pursued a rapid, retrogressive course. If the bone marrow was heavily involved, the clinical appearance was that of a blood dyscrasia. If the lungs were extensively involved, respiratory symptoms attracted the greatest attention. The question arises whether the tumor cells reach the bone marrow by way of the blood stream or by the lymphatic channels. Maximow and Bloom<sup>13</sup> say that lymphatics have not been demonstrated in the bone marrow, but the interesting experiments of Kolodny<sup>11</sup> cast doubt on this statement.

In correlating the roentgenologic manifestations with the pathologic findings it seemed evident that the presence of masses of tumor cells within dilated lymphatics around bronchi and blood vessels was responsible for the peculiar roentgenologic pattern. Since the roentgen findings were similar in all cases it is believed that the microscopic severe arterial damage and tumor cell invasion of the bronchial lumina played a negligible part in the formation of roentgenologic appearance. Infiltration of alveolar spaces by tumor cells may account

\* Case Records, Massachusetts General Hospital, Case 29291. *New England J. Med.*, 1943, 229, 180.

for the larger densities which were occasionally found on the roentgenograms and which were difficult to explain solely on lymphatic involvement. Fibrosis, pulmonary edema, and blood vessel congestion, which under certain conditions may resemble the roentgenologic appearance of lymphatic spread, were not found in any of our autopsied cases to the extent that could produce visible changes on the roentgenogram.

#### DIFFERENTIAL DIAGNOSIS

Despite the fairly definite roentgen appearance of lymphatic spread, a number of other conditions resemble it very closely. Foremost among the possible differential diagnoses is *miliary tuberculosis*. Both clinically and roentgenologically the two conditions resemble each other. Cyanosis, severe dyspnea and fever may occur in both. The age group in miliary tuberculosis is usually, but not always, younger. Roentgenologically, there are certain differential points. In miliary tuberculosis, the hilar shadows are as a rule less dense, and enlargement, if present, is less marked; the string-like design so characteristic of lymphatic metastasis is not present, but instead the fine nodular shadows scattered over the lung represent the typical appearance. The upper portions of the lungs are usually involved in miliary tuberculosis while they are less apt to be involved in metastatic malignancy.

*Pulmonary congestion and edema* may also present a similar diffuse string-like design roentgenologically, due to congestion in the blood vessels. The lung fields are often hazy because of edema; the blood vessels tend to become smaller toward the periphery. In lymphatic spread, on the other hand, the characteristic design is more uneven, the lymphatics growing smaller in certain areas and in others becoming thicker toward the periphery. Roentgenoscopic examination of the heart may be helpful in some cases as a differential procedure. Clinically dyspnea, respiratory embarrassment and cyanosis are common in both conditions.

*Pneumoconiosis*, in contrast to lymphatic spread of cancer, presents, as a rule, a much denser roentgen appearance with more circumscribed, harder nodules. Some forms of pneumoconiosis, especially the acute type, may be extremely difficult to differentiate, but these cases are fairly rare, and the history of exposure may help in the diagnosis when other differential points fail.

In some cases of *sarcoid* the involvement of the lungs simulates the roentgenologic appearance of lymphatic spread of cancer. However, in sarcoid the involvement of the hilar lymph nodes is usually characterized by sharply defined masses which are present equally on both sides. Enlargement of the spleen may give confirmatory evidence in some cases, and as a rule the marked roentgenologic involvement is in great contrast to the minimal clinical manifestations.

Other conditions which must be ruled out are primary *fibrosis with emphysema*, and *bronchiectasis* as in Case 1. In these two conditions a long history dating back farther than would be the case in lymphatic metastatic malignancy is usually elicited.

In addition to the preceding differential possibilities, there have come under our observation recently some cases of *atypical pneumonia*, in which the roentgen appearance in its resolving stages somewhat resembles lymphatic spread of cancer. The clinical history of a preceding upper respiratory infection would, however, establish the diagnosis of pneumonia.

Although, as a whole, the roentgenologic findings are quite typical and can be distinguished from other conditions by careful study, in the individual case a definite diagnosis may be difficult unless other roentgenologic or clinical evidence of malignant disease exists.

#### SUMMARY

Ten cases of lymphangitic carcinosis of the lungs, seen in recent years at the Massachusetts General Hospital, are presented to illustrate the lymphatic spread of cancer. Autopsy was performed on seven of the group.

The roentgenologic appearance presents a typical pattern which is entirely different from that of the usual pulmonary metastasis. It is characterized by a network of increased density, radiating from enlarged hilar lymph nodes and trabeculating through the lung fields in an uneven manner, and is interspersed by numerous fine nodules. It is more marked in the lower and central portions of the lungs and occasionally may be unilateral. Differential diagnoses of miliary tuberculosis, pulmonary edema and congestion, sarcoid, pneumoconiosis, and bronchiectasis, among others, must be ruled out.

The microscopic picture in the lungs is characterized by widespread permeation of the lymphatics by tumor cells and, in a certain number of instances, profound arterial damage. Anaplasia of the tumor, rather than its primary site, appears to be the important factor in this form of dissemination.

The age and sex incidence, the mode of spread and the arterial changes are discussed.

The common clinical findings are dyspnea, cyanosis, productive cough and rapid cachexia. Pulmonary signs are minimal, but pulmonary symptoms overshadow those which arise from the primary tumor.

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# PULMONARY CHANGES IN CARDIOSPASM

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TWO cases of severe cardiospasm are presented which demonstrate extensive pulmonary changes in the roentgenograms, yet presented no significant pulmonary signs or symptoms. One case, after six years of observation, had a short episode of fever, cough, dyspnea and hemoptysis which was diagnosed as influenza. At no other time was there evidence of cough, dyspnea or auscultatory abnormalities with either patient. Their complaints were limited to manifestations of esophageal obstruction and distention.

In previously reported cases of cardiospasm with changes in the chest roentgenograms, there have been associated cough,

pain, dyspnea, etc. In such cases, the patients had ailments referable to pulmonary disease as well as to cardiospasm.

## CASE REPORTS

CASE 1. In 1935, a male, aged fifty-seven, was admitted as an out-patient to the Mary Fletcher Hospital, Burlington, Vermont, for roentgen examination of the esophagus and stomach. He gave a history of intermittent difficulty in swallowing and occasional regurgitation of food.

Roentgen examination showed the esophagus slightly dilated, terminating below in a smooth, rounded defect, and a diagnosis of achalasia (cardiospasm) was made.

Two years later, he was admitted to the same hospital with similar complaints. He stated that his throat would feel filled after a few swallows of food or liquid and he would have to stop eating. He would lose considerable weight during these periods, then gain for a short time. During the month prior to admission, he had lost 14 pounds. There had been no cough and only one attack of vomiting.

Physical examination of the chest disclosed no abnormalities. Roentgenoscopy and roentgenography demonstrated slightly increased dilatation of the esophagus over that previously noted. Both lung fields (Fig. 1) showed evidence of a moderate amount of fibrosis, most prominent in the right upper lobe and in the vicinity of the interlobar septa on both sides.

The cardia was dilated, with partial relief of symptoms.

In 1941, he re-entered the hospital, weighing only 95 pounds. Again (Fig. 2), chest roentgenograms showed a marked increase in linear markings in all portions of both lungs with a distribution suggesting diffuse interstitial fibrosis. Bougies were passed, and the patient gained 11 pounds during the following month.

His final admission was in March, 1943. Three weeks prior to admission, he had had



FIG. 1. Case 1. 1935. Moderate fibrosis of both lung fields, most prominent in the right upper lobe.

"flu" with a temperature of  $101^{\circ}$  F. and slight hemoptysis. For one week, he had regurgitated several times a day. On admission, he was free from cough, expectoration and fever, and physical examination of his chest revealed no abnormalities. A roentgenogram of the chest showed no change. Esophagoscopy and dilatation were done, and the patient was subsequently discharged improved.

*Comment.* A man, aged fifty-seven, was followed for six years after cardiospasm was proved by roentgen examination. During this time, the lungs showed evidence of in-



FIG. 2. Case I. Six years later.

creasing fibrosis, apparently interstitial. He had one brief episode of cough and hemoptysis. Physical examination of the chest never showed any abnormality.

**CASE II.** A soldier, aged thirty-one, a former mechanic, had noted, over a period of four years, gradual and progressive difficulty in swallowing. Food seemed to stick in the upper part of the esophagus and at times he felt as if it would shut off his breathing entirely. Liquids aided the emptying of the esophagus. He would hiccup frequently after eating. Occasionally he would awaken at night to find his mouth filled



FIG. 3. Case II. 1940. Note the large area of hazy density against the horizontal fissure on the right.

with regurgitated food and fluid. He never choked on this material and, after spitting it out, could go back to sleep.

Three years before, the diagnosis of cardiospasm was established roentgenologically in a civilian hospital. Figure 3 is a posteroanterior roentgenogram of the chest taken at that time. Above and resting upon the horizontal fissure between the right upper and middle lobes there is a hazy area of increased density.

The patient had no pulmonary symptoms. A dilatation was performed with temporary relief.

At present, roentgenoscopy shows a dilated esophagus which is slightly elongated and which shows conical narrowing toward the cardia. Roentgenogram of the chest shows the same area of increased density in the right upper lobe (Fig. 4). On rotating the thorax under the roentgenoscope, this area is shown to lie in the parenchyma, but touching the lateral parietal pleura. The pleura is not demonstrably thickened over it and no cavities are seen.

Bronchoscopy and lipiodol filling of the bronchial subdivisions of the right lung showed no abnormality of the mucosa or size of the bronchioles.

*Comment.* A soldier with a history of four years of cardiospasm showed an area of increased density in the right upper lobe which persisted over a period of three years. It was thought to represent an area of fibrosis which developed from inhalation pneumonitis.

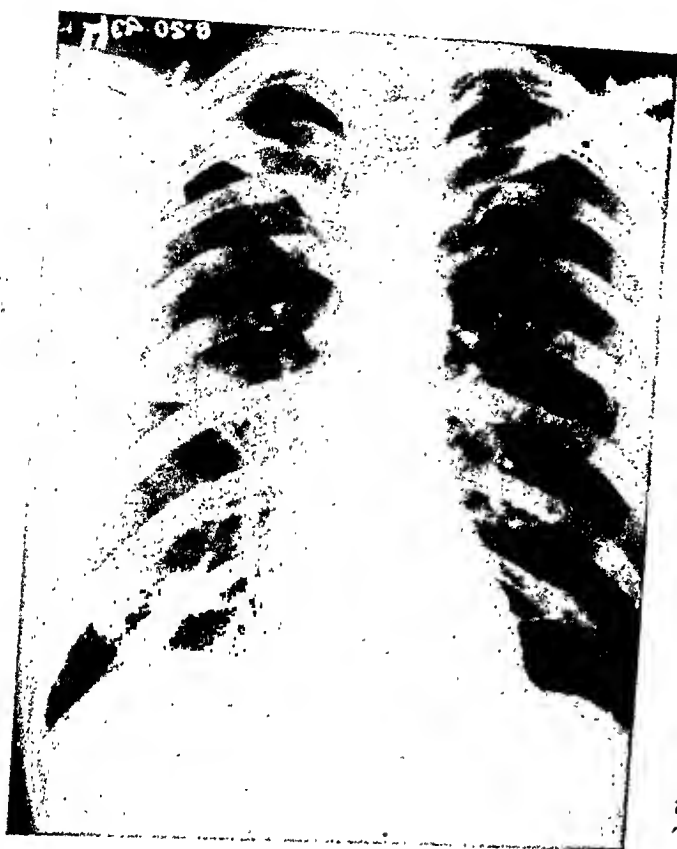


FIG. 4. Case II. Three years later. The area has not changed in size or shape.

#### ETIOLOGY OF PULMONARY CHANGES

Patients with cardiospasm are bothered frequently by coughing<sup>1</sup> and occasionally by sudden paroxysms of strangulation.<sup>1,11</sup> This is more often precipitated or aggravated by lying down, or may occur during sleep.<sup>5</sup> At that time, with the esophagus nearly horizontal, the large reservoir of food and fluid may spill into the pharynx and be aspirated. If asleep, the patient may be aroused by severe coughing. He may find his mouth and throat filled with fluid and food which will take several seconds to fully clear away. At times, however, this fluid descends farther into the bronchi and may lead to pulmonary disease.

Four types of pulmonary changes (roentgenologically) have been reported: basal pneumonitis, lung abscess, bronchiectasis and pleural effusion.

*Basal Pneumonitis.* Basal pneumonitis as a complication of cardiospasm was reported first in 1914 by Eisenstein<sup>3</sup> as double pneumonia. Mallory<sup>6</sup> reported the case of a man, aged sixty-four, who had suffered with cardiospasm for fifteen years; cancer developed at the lower end of the esophagus, leading to obstruction and death. "At the right lung base there was pneumonia or consolidation with many abscess cavities within the area." This was called an inhalation pneumonia.

The second case reported by Mallory<sup>7</sup> was a sixty-two year old woman who had had cardiospasm for forty-one years. A roentgenogram taken twenty-three days before death showed dullness at both bases posteriorly which was thought to be an aspiration pneumonia. However, at the time of autopsy, the lungs were clear.

The fourth case was seen by Schmidt.<sup>11</sup> A six year old girl was admitted with a history of repeated pulmonary infections over a period of two years, associated with fever. There were moist râles at both bases. With relief of cardiospasm by bouginage, the pulmonary symptoms ceased.

Lipoid pneumonia at both bases as a complication of cardiospasm was described by Thomas and Jewett.<sup>12</sup> A man, aged thirty-two, had suffered from cardiospasm for four years. In the recent months, cough and fever had been recurrent and râles were present at both bases. A roentgenogram of the chest revealed a hazy, finely mottled consolidation throughout the right lung and at the left base. Microscopic section of the lungs removed at autopsy showed numerous globules of fat scattered throughout patchy areas of consolidation in the bases. The fat probably originated from a high milk and cream diet that had been taken during the past months.

*Lung Abscess.* This has been reported twice in the literature as a complication of



cardiospasm. In 1927, Vinson<sup>13</sup> had a forty-two year old male patient who, after ten years of cardiospasm, developed cough with foul bloody sputum and fever. A large abscess cavity was found in the right upper lobe by roentgen examination. After esophageal bouginage, the pulmonary abscess cleared rapidly. A similar case was seen by Sampson.<sup>9</sup> Symptoms had been present for several months. On admission, the roentgenogram showed consolidation in the right middle lobe. He was treated conservatively and symptoms disappeared. In the course of the next three months, however, a cavity developed in the right middle lobe, which remained without causing symptoms for six years. A pneumolith rolled about in the bottom of this cavity. The patient, meanwhile, had no symptoms and the cardiospasm had been completely relieved. The long duration of the cavity without surrounding pneumonitis is noteworthy.

*Bronchiectasis.* The third pulmonary complication of cardiospasm is bronchiectasis. In 1933, Reeke<sup>8</sup> reported the case of a female, aged nineteen, who had been coughing for several years and showed clubbing of the fingers and toes. Study was concentrated on the lungs and bronchiectasis was demonstrated roentgenographically on both sides. Later cardiospasm was found which was so severe that gastrostomy was performed. Pneumonia ensued and the patient died. Autopsy confirmed the diagnosis of cardiospasm and bilateral bronchiectasis.

In the second case, reported by Schrire,<sup>10</sup> cough had been present for six years, with frequent attacks of pneumonia. At the age of twelve, bronchiectasis was discovered in the right middle lobe. One year later, a second bronchogram showed spread of the bronchiectasis into the right lower and left upper lobes. Six months later, cardiospasm was found for the first time and a bougie passed. There was immediate gain in weight and complete cessation of cough. One year after bouginage, bronchoscopy showed no disease. Relief of the cardio-

spasm had stopped the repeated trickling of the esophageal fluid into the trachea and bronchi. This was followed by healing of the chronic pulmonary disease. In other words, this may be a case of so-called "reversible bronchiectasis." Removal of the focus allowed the disease to regress.

*Pleural Effusion.* Chandler<sup>2</sup> reported the case of a female, aged fifty-one, who had had difficulty in swallowing for several months. She was seen first with a large pleural effusion and gave a history of transient chest pain five weeks before. One month later, cardiospasm was diagnosed and atropine given. The difficulty in swallowing and effusion disappeared simultaneously.

#### DISCUSSION

To these four complications of cardiospasm, we have added 2 cases of probable interstitial pulmonary fibrosis. In both cases, the lesions were observed over several years without change. Bronchoscopic and bronchographic studies of one patient revealed no abnormalities. The patients were asymptomatic from the pulmonary changes, although they suffered greatly from cardiospasm. The etiology of pathological condition in the lung is apparently inhalation of esophageal contents with pneumonitis and consequent fibrosis.

#### SUMMARY

Two cases of cardiospasm are reported with long-standing asymptomatic pulmonary lesions, probably interstitial fibrosis following aspiration pneumonitis. Attention is called to certain other pulmonary and pleural complications, some of which may be relieved by treatment of the primary condition.

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# CONGENITAL APLASIA OF THE LUNG

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THE antemortem diagnosis of agenesis of the lung with bronchographic follow-up for an interval of seven years is sufficiently rare to warrant addition to the roentgenological literature.

Madigan<sup>8</sup> reported 36 proved cases with postmortem findings of each. Van Loon and Diamond<sup>10</sup> recorded 40 genuine cases. Hurwitz and Stephens<sup>6</sup> describe an additional case and review 34 authentic cases adequately recorded in the literature. Additional solitary cases are recorded by Yampolsky and Fowler,<sup>11</sup> Elward,<sup>4</sup> Stokes and Brown,<sup>9</sup> and recently De Weese and Howard,<sup>3</sup> as well as many others in the foreign literature. The sum total did not appear to exceed one hundred proved cases, with a great majority of these representing postmortem findings and observations.

## CASE REPORT

E. B. The patient was first seen at the chest clinic of the Cincinnati General Hospital on March 27, 1935, because of a tuberculous contact with an aunt. He had always been underweight and somewhat underdeveloped, now weighing 31 pounds (average weight 38 pounds). There is a past history of frequent colds, measles, pertussis, and an episode of pneumonia when he was eight years of age. Except for the tuberculous aunt the family history is negative.

Physical examination at this time shows marked contraction of the left hemithorax with a flat percussion note and diminished breath sounds except at the left apex. No râles were heard. The right chest was clear. A roentgenogram showed the entire left hemithorax to be opaque with the heart located near the left lateral chest wall. Two follow-up roentgenograms over a period of five years showed no significant changes.

The patient was next seen in the Children's Hospital where bronchograms were done (Fig. 1) after an episode of bronchopneumonia at the right base had subsided. He apparently was in

good health during this interval until December, 1941. At this time he was again seen in the chest clinic at the Cincinnati General Hospital where no subjective complaints were elicited except that he failed to gain weight (55 lb.—average 67 lb.). P. P. D. No. 1 and No. 2 have been consistently negative over this period of observation. Bronchograms under bronchoscopic control were again done and the same findings in the left main stem bronchus, mediastinal shift to the left, and compensatory emphysema on the right were again demonstrated (Fig. 2).

The bronchoscopist (Dr. Sam Iglauer) reported that the left main stem bronchus was found to be 1.5 cm. in length, ending abruptly with a perpendicular carina and two small

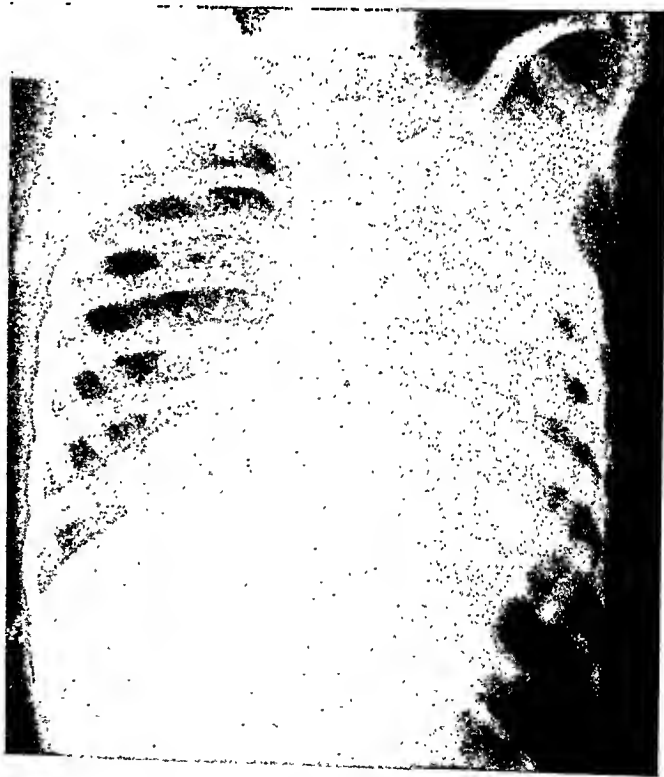


FIG. 1. March, 1935. Bronchogram showing the blunt filling of the left main stem bronchus with lipiodol. Homogeneous opacity of the entire left lung, with the trachea, heart and mediastinum shifted to the left. The left diaphragm is outlined by the distended fundus of the stomach. The right lung shows a moderate degree of emphysema. (Courtesy of Dr. William M. Doughty, Children's Hospital, Cincinnati, Ohio.)



FIG. 2. January, 1942. Follow-up bronchogram showing no significant change after an interval of seven years.

bronchi, 2 mm. in diameter. In his opinion, this represented a congenital failure in the development of the left bronchial tree and lung.

The latest roentgenogram, taken when the patient had another episode of pneumonia at the right base in March, 1943, still demonstrated no change in the findings relative to the left lung.

#### DISCUSSION

Clinically this congenital anomaly is asymptomatic. The general development is good or slightly delayed for the age of the patient. There may be slight flattening and diminished movement of the affected side. The heart and mediastinal structures are displaced to the side of the absent lung with the apical impulse being pronounced. Flatness and dullness are usually present to percussion while the breath sounds are absent or suppressed on auscultation. The left lung has a greater incidence of aplasia than the right in the ratio of two to one. The presence of an aplastic lung is consistent with a normal life if the patient survives

the first year of life. One patient lived to the age of seventy-two, dying of a cerebral vascular accident.<sup>1</sup>

The principal roentgen findings show the displacement of the heart and mediastinal structures to either side with slight elevation of the ipsilateral diaphragm and narrowing of the intercostal spaces on the affected side. The contralateral lung usually shows increased aeration, indicating a significant degree of compensatory function.

Paralysis of the diaphragm from whatever mechanism, congenital absence of the diaphragm, diaphragmatic hernia and intra-bronchial foreign body are to be considered in the differential diagnosis. Bronchoscopy and bronchography are the two important procedures in establishing the clinical diagnosis by excluding the above-mentioned conditions.

Arey,<sup>1</sup> in his discussion of the embryonic development of the respiratory system, says: "A groove-like evagination arises on the ventral side of the esophagus in the 3 mm. embryo. From the enlarged posterior ends of the groove two small lung buds grow out. Later in the development, the trachea and esophagus become separated by a constriction interrupted at the cephalic end of the larynx which is indistinguishable at the end of the fifth week. Muscle fibres and cartilaginous rings differentiate from the surrounding mesenchyme at the end of the seventh week. In a later metamorphosis of the lung buds, hollow evaginations grow out into the envelop of the connective tissue, enlarge and continue to branch, producing a tubular system. From the fine terminal tubules arise small outgrowths which constitute the pulmonary alveoli." The etiology of the aplasia is obscure. The most rational explanation for aplasia of the lung ascribes the condition to a developmental error of endogenous origin, perhaps primary in the pulmonary vascular system.

#### SUMMARY

A case of congenital aplasia of the left lung with bronchographic follow-up over a

period of seven years is presented together with a review of the literature.

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# ACUTE OBSTRUCTION OF THE COLON

## DIFFERENTIAL DIAGNOSIS BETWEEN VOLVULUS AND CANCER OF THE SIGMOID COLON BY PRELIMINARY ROENTGENOGRAM\*

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LESIONS of the sigmoid colon may first make their presence known by symptoms of an acute obstruction. The most common lesions that are apt to produce such an obstruction are cancer of the sigmoid and volvulus.

It is the purpose of this paper to present roentgenologic diagnostic criteria for the differentiation of the obstruction due to a cancer, from that obstruction due to a volvulus, which may be seen in a preliminary roentgenogram of the patient. The difference in the appearance of the bowel in the two conditions is due to the fact that one is the result of a slow-occurring obstruction, allowing the bowel to accommodate itself to the increasing pressure, while the other is due to a sudden obstruction.

A search through the literature shows that volvulus has been diagnosed from the roentgenogram by other observers. Høyer<sup>2</sup> mentions the roentgen findings in a volvulus of the sigmoid as a large loop of distended bowel rising out of the pelvis. These are similar to the findings in the cases reported in this paper.

Miller,<sup>11</sup> reporting a case of volvulus in a child, mentions a large loop of gas distended bowel in the roentgenogram taken preoperatively, but fails to state whether the diagnosis of volvulus of the sigmoid was made from this roentgen finding. Volvulus has been diagnosed roentgenologically by the use of the barium enema (Hall<sup>12</sup>). None of the above mentioned authors point out differential criteria for a roentgen diagnosis of the slowly growing obstruction of the sigmoid which may be present in the cancer, from the sudden obstruction by a twisting of the bowel which is present in the volvulus.

Volvulus is a twist in the bowel usually over 180° and may occur anywhere in the gastrointestinal tract. It accounts for about 10 per cent of all cases of bowel obstruction (Wangensteen<sup>13</sup>). The sigmoid colon is especially likely to become twisted if it has a long mesentery with a narrow base in proportion to its length. There is a great variation in the normal length of the sigmoid, and the longer the loop and the closer its fixed ends, the greater the likelihood of volvulus. Chronic volvulus can occur (Holmgren<sup>4</sup>) with few symptoms, but it is the acute volvulus with which we are concerned since this is the case which requires prompt diagnosis and proper treatment or the mortality will be high.

Cancer of the sigmoid and volvulus of the sigmoid may make their presence known for the first time by a sudden bowel obstruction. Both types of cases will have a distended abdomen, some pain, but may have a normal pulse, temperature and white count. A correct diagnosis is imperative before any operative procedure is instituted. In cancer of the sigmoid, a right-sided incision for a cecostomy is in order to relieve the distention, and to drain the bowel. It is also advantageous to have the stoma as far as possible from the subsequent left side incision for a resection. On the other hand, a right-sided incision is of no value for a sigmoid volvulus. Here the choice is a left paramedian incision. Hence the necessity for a differential diagnosis.

It has been a routine procedure in our hospital<sup>1,6,7,8,9</sup> to take preliminary roentgenograms of all abdominal cases where an obstruction is suspected. It has been possible to make a differential diagnosis on the preliminary roentgenogram between a

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cancer in the sigmoid from a volvulus of the sigmoid in a few instances when such cases presented themselves.

A review of the course of events in both these conditions will suggest the criteria that may be available in both instances. Both depend upon gas appearing in the bowel. Gas may normally be present in the colon, but the colon is under no undue distention. With a block from either cause there is an accumulation of gas. It is the character of the gas-filled loops that differentiates the two conditions.

*Cancer of the Sigmoid Colon.* This is usually a slowly growing tumor within the lumen of the bowel. This part of the colon is narrow and muscular. With increasing obstruction it maintains its tone and size. On the contrary, the cecum and ascending colon, being of greater diameter and thinner of wall, accommodate themselves to the increasing back pressure by dilating. The dilatation of the cecum may progress to such an extent that rupture occurs before symptoms of sigmoid obstruction appear, and the patient may be seen first with right-sided peritonitis (Saeltzer and Rhodes<sup>12</sup>). Most often the patient is rushed to the hospital, with the abdomen markedly distended and in pain, considered to be suffering from acute intestinal obstruction without cancer being suspected.

A roentgenogram of the abdomen in the supine or prone position will show a colon filled with gas, to the point of obstruction. The cecum and ascending colon are on the right side, they are dilated, lie in a vertical direction, and may have redundant loops. The transverse colon crosses the abdomen, it may also have redundant loops and is also dilated. The descending colon is well seen on the left side lying in a vertical direction, either not distended or with relatively little distention. The interruption of the gas-filled bowel is seen to be sharp at the point of obstruction. No large gas-filled loops are seen rising out of the pelvis.

Cancer obstructing other parts of the colon causes a similar appearance, i.e. gas-distended colon extends to the point of ob-

struction. In all instances careful observation of the appearance of the gas-distended loops will show it to be colon which shows a continuity of distention to the point of obstruction. If the ileocecal valve is competent the distention is limited to the colon, but it has been observed that the small intestine has been distended by obstruction of the colon.

*Volvulus of the Sigmoid.* In this instance there is a sudden twisting of the sigmoid bowel loop and it becomes a closed loop obstruction in relation to the rest of the bowel. This closed loop rapidly becomes greatly distended with gas and is seen to rise out of the pelvis and occupy the middle of the abdomen. It may extend to the diaphragm. At the summit the loop makes a sharp hair-pin turn. The origin of the gas is questionable. Weinstein<sup>14</sup> explains the accumulation of the gas as the result of the torsion completely cutting off the circulation, causing a deficient arterial oxygen supply to the involved loop. As there is some circulation to the bowel, with no impairment of the venous flow, an exchange of gases between the impaired circulation and the gas in the bowel takes place, carbon dioxide replacing the oxygen in the involved loop. The increasing amount of carbon dioxide plus other gases makes an ideal culture medium for the anaerobic organisms normally present in the colon with subsequent development of more gas. To substantiate this view he cites the foul odor that is present in a volvulus due to the anaerobic gases developed.

If a torsion is complete, the fluid in the bowel will exceed the gas present (Wangenstein<sup>13</sup>). A strangulated, gangrenous bowel may show no gaseous distention, either of the involved loop or of the bowel proximal to the volvulus.

It is of aid to take anteroposterior or posteroanterior roentgenograms with the patient lying on his side. Often a small amount of gas present with considerable fluid in the obstructed gut can be demonstrated, when no gas can be seen in the routine supine position.

The volvulus itself may act as a mechanical block, resulting in dilatation of the bowel proximal to it. This distended bowel never reaches the dilatation of the twisted loop and by its position can be identified as colon.

If the twist is complete and the acute obstruction is not promptly relieved, the bowel wall will become edematous, fol-

onset of pain the abdomen became distended.

On admission to the hospital, examination showed a distended abdomen, tympanitic but soft. No masses could be palpated.

The temperature, pulse and respiration were normal. The white blood count was 8,500, with a normal differential; red blood count was 3,560,000.

Roentgen examination of the abdomen showed a distended colon to the middle of the

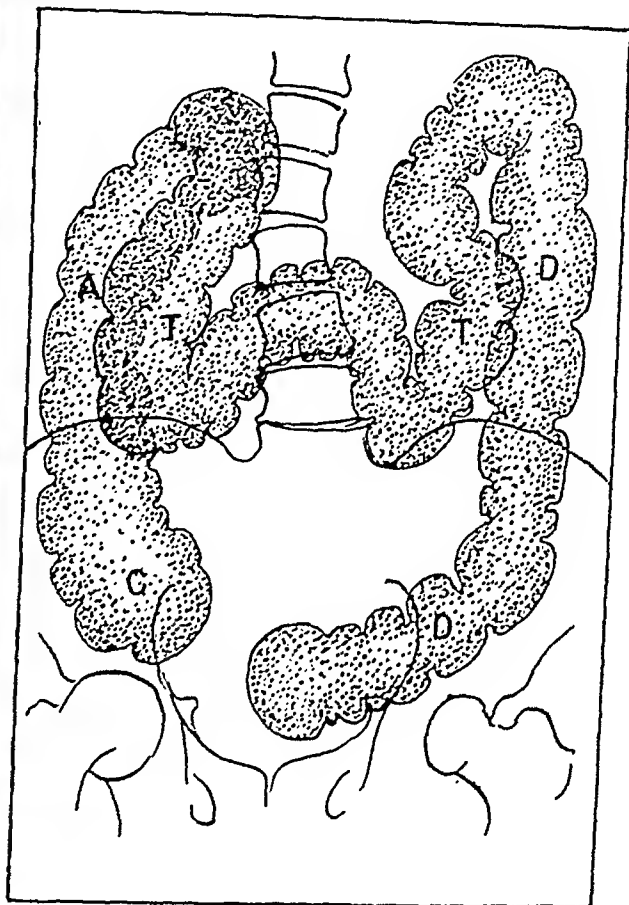


FIG. 1. Case 1. Cancer of sigmoid colon. Colon distended with gas to the sigmoid. Redundant loops of transverse colon. Diagnosis: Mechanical obstruction of the sigmoid, probably due to cancer. C, cecum; A, ascending colon; T, transverse colon; D, descending colon.

lowed by gangrene, perforation and peritonitis.

Thus, an early differential diagnosis between the two types of obstruction is most important, so that the proper surgical procedure can be instituted.

#### CASE REPORTS

CASE I. B. G., female, aged fifty-eight, had an onset of cramp-like pains in the left lower quadrant at regular intervals of three to five minutes eighteen hours prior to entry. With the

sigmoid (Fig. 1). A diagnosis was made of a mechanical obstruction of the sigmoid colon, probably due to cancer.

A first stage cecostomy was done, followed in a few weeks by the removal of a carcinoma. There was insufficient bowel to perform an anastomosis so a colostomy was done.

CASE II. E. S., female, aged sixty-eight, enjoyed good health until twelve hours before admission to the hospital. At that time she complained of griping pain in the left lower quadrant increasing in severity.

Examination on admission to the hospital showed a moderately distended abdomen; no palpable masses. The temperature, pulse and respiration were normal.

Roentgen examination of the abdomen showed a distended colon with redundant loops of transverse colon. The distention extended down the descending colon to the sigmoid (Fig. 2). Diagnosis was made of mechanical obstruction of the descending colon, probably due to cancer.



Roentgen examination of the abdomen in supine position showed a distention of the colon extending to the rectosigmoid (Fig. 3). A diagnosis was made of mechanical obstruction of the rectosigmoid, probably due to cancer. This was confirmed by a barium enema where an obstruction was met at this point.

A cecostomy was performed followed in two weeks by a resection for cancer and a permanent colostomy.

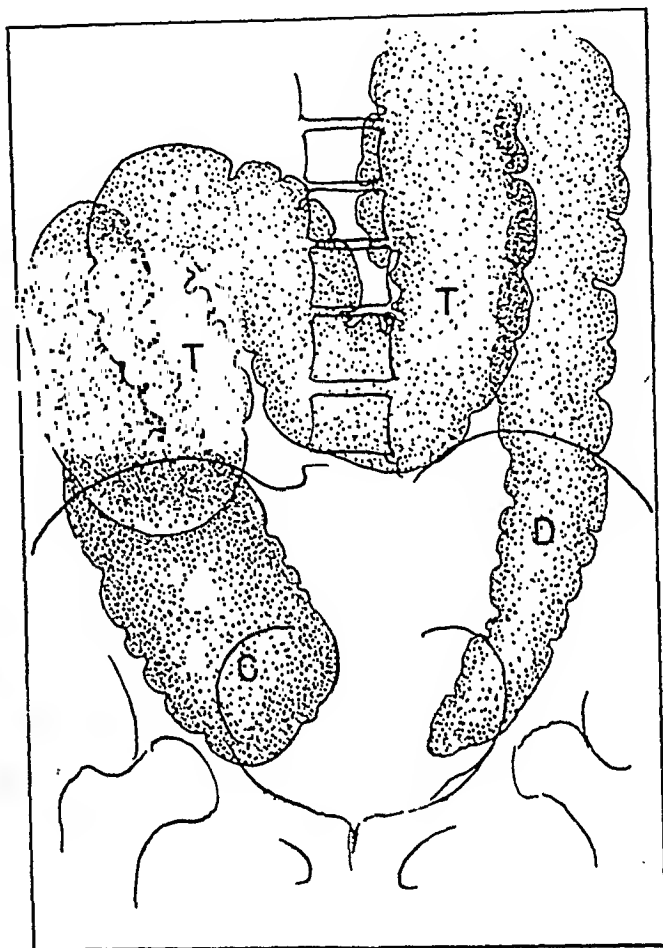


FIG. 2. Case II. Cancer of sigmoid colon. Colon distended with gas to the sigmoid. Redundant loops of descending colon. Diagnosis: Mechanical obstruction of the sigmoid, probably due to cancer. C, cecum; A, ascending colon; T, transverse colon; D, descending colon.

A first stage cecostomy was done followed in a few weeks by a resection for cancer and an end to end anastomosis.

CASE III. B. S., female, aged sixty-six, had intermittent cramps in the left lower quadrant and a sense of fullness on the right side for two days prior to admission to the hospital.

Examination in the hospital showed a distention of the abdomen with no localized tenderness. Temperature, pulse and respiration were normal. White and red blood counts were normal.

CASE IV. C. M., male, aged fifty, had a sudden onset of griping abdominal pain and distention following his evening meal. The pains were intermittent and mostly in the lower quadrants. He had daily bowel movements and vomited only once.

He entered the hospital three days after the onset. Examination showed a moderately distended abdomen, no tenderness or masses. The temperature, pulse and respiration were normal. The white blood count was 10,350, with normal differential, and the red blood count was 4,540,000.

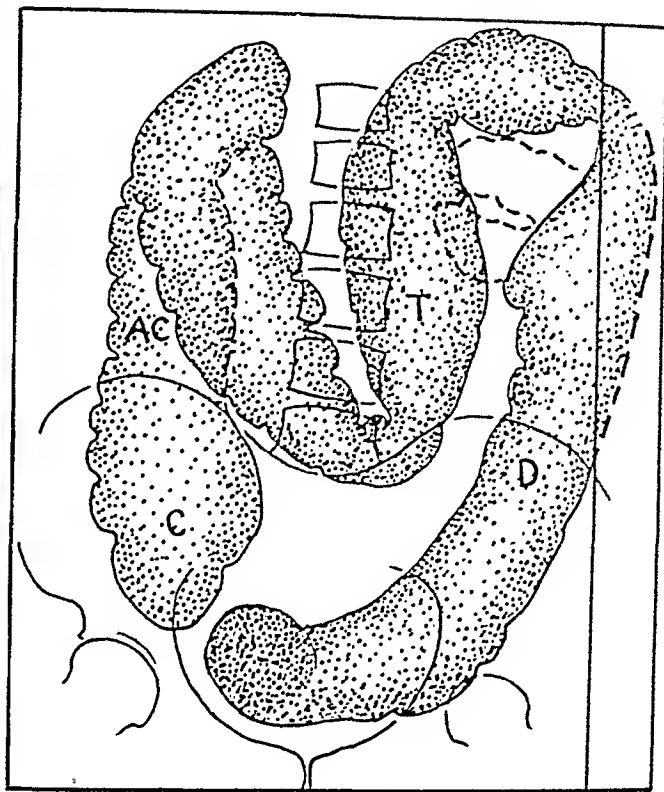


FIG. 3. Case III. Cancer of sigmoid colon. Colon distended with gas to the junction of the descending colon and sigmoid. Redundant loops of transverse colon. Diagnosis: Mechanical obstruction at junction of descending colon with sigmoid, probably due to cancer. *C*, cecum; *T*, transverse colon; *D*, descending colon.

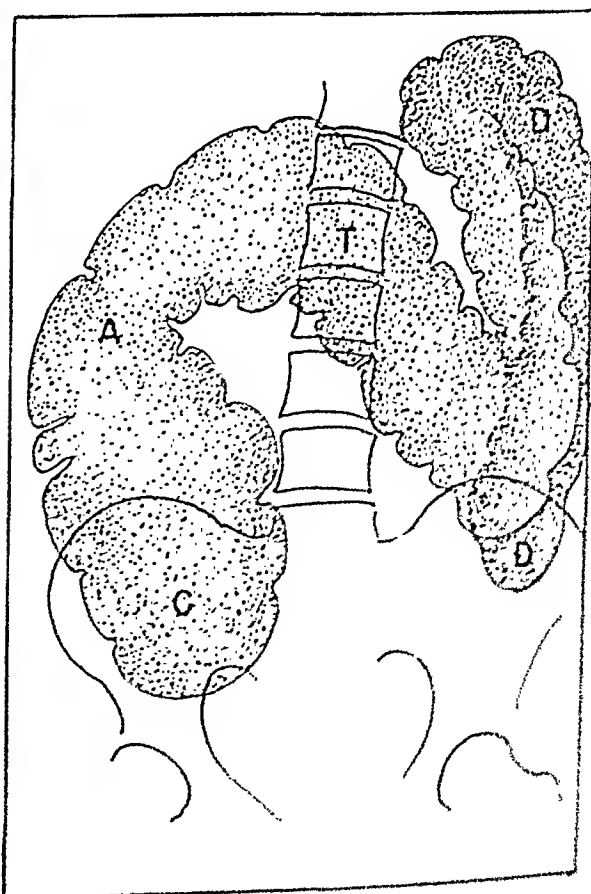


FIG. 4. Case IV. Cancer of sigmoid colon. Colon distended with gas to lower third of descending colon. Redundant loops of transverse colon. Diagnosis: Mechanical obstruction of descending colon, probably due to cancer. *C*, cecum; *A*, ascending colon; *T*, transverse colon; *D*, descending colon.

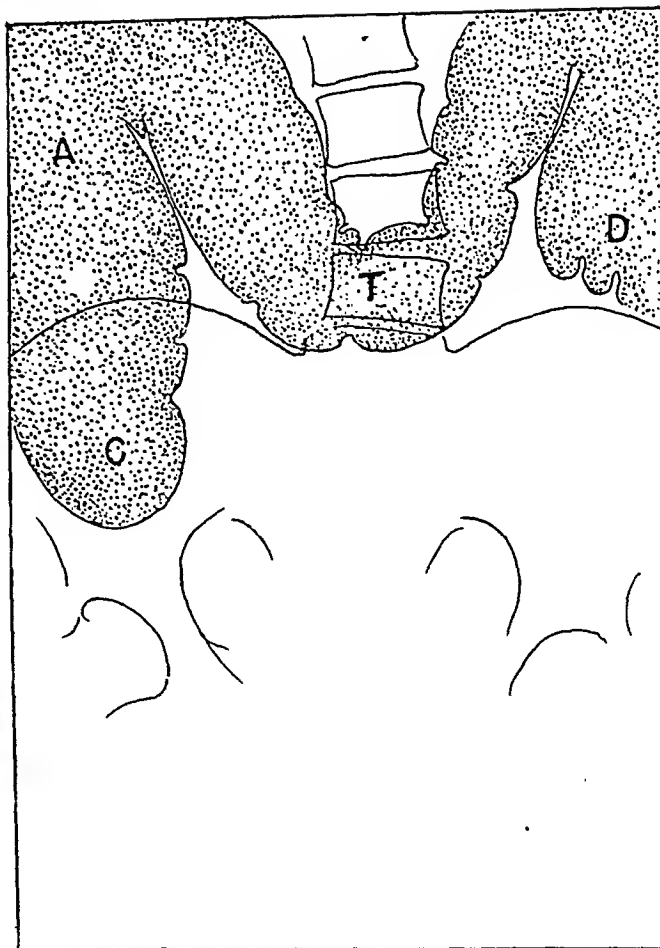


FIG. 5. Case v. Cancer of descending colon. Colon distended with gas to middle of descending colon. Diagnosis: Mechanical obstruction in the middle third of descending colon, probably due to cancer. C, cecum; A, ascending colon; T, transverse colon; D, descending colon.

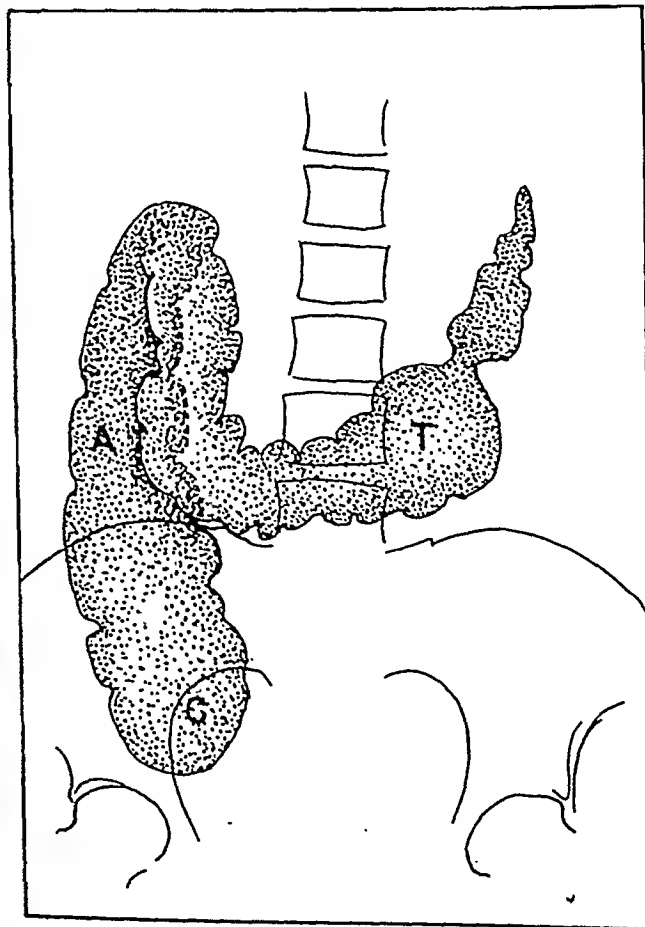
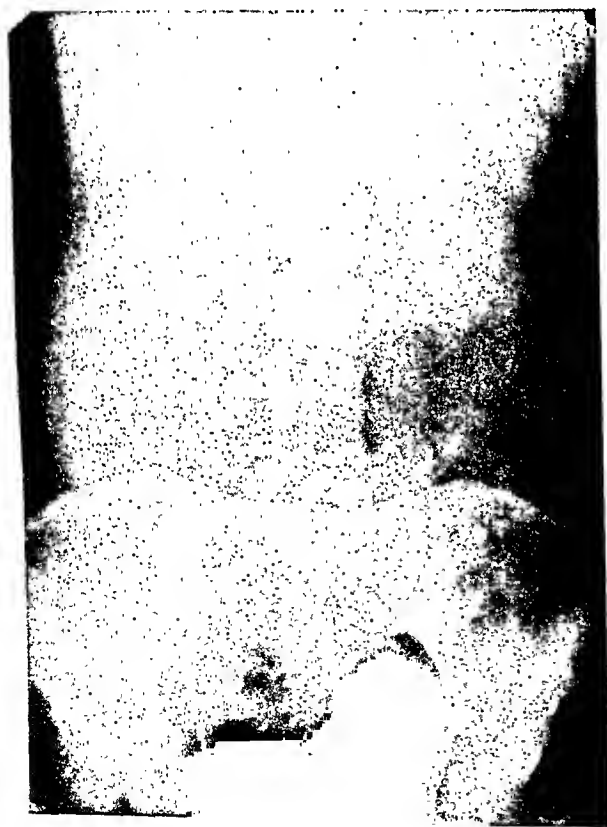


FIG. 6. Case vi. Cancer of transverse colon. Distention of cecum, ascending and proximal half of transverse colon. The transverse colon gradually tapers off, becomes funnel-shaped and finally becomes occluded. No gas is seen in bowel distal to this point. Diagnosis: Mechanical obstruction in middle third of transverse colon, probably due to cancer. C, cecum; A, ascending colon; T, transverse colon.

Roentgen examination of the abdomen in supine position showed distention of the colon to the sigmoid where the gas-filled colon abruptly stopped. The cecum was markedly distended (Fig. 4). The diagnosis was mechanical obstruction of the sigmoid at the junction with the descending colon, probably due to cancer.

A first stage cecostomy was done followed

mal. The red and white blood count was normal.

Roentgen examination showed gas distended from the descending colon to the pelvic brim to the cecum. The cecum was markedly distended (Fig. 5). Diagnosis was cancer of the descending colon at the junction of the pelvic brim.

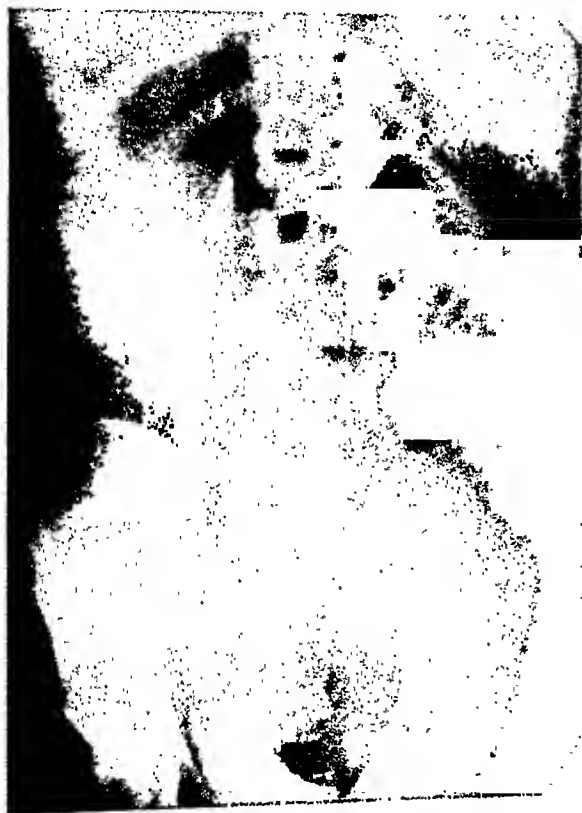
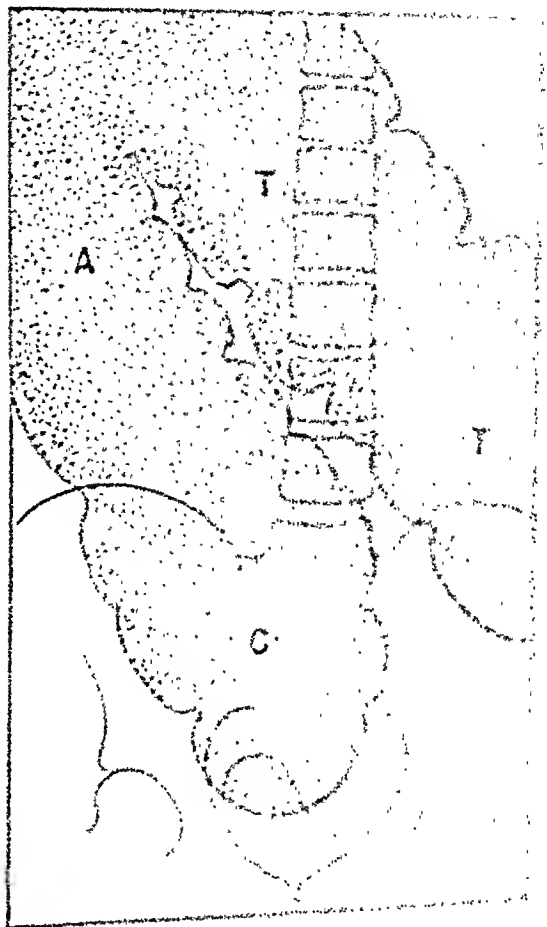


FIG. 7. Case VII. Cancer of transverse colon.

The cecum, ascending and transverse colon are markedly distended, the distended transverse colon extending farther than shown on the roentgenogram. The diagnosis of an obstructed colon was suggested and confirmed by intravenous pyelography to determine the nature of a later resection. The distended colon was visualized and some dye is seen in the bladder. The diagnosis of cancer of the transverse colon was confirmed by routine pyelograms. Diagnosis: Mechanical obstruction of transverse colon at junction of cecum; A, ascending colon; T, transverse colon.



three weeks later by a resection for cancer of the sigmoid and an end to end anastomosis.

CASE V. E. M., female, aged seventy-eight, was unable to pass feces or flatus for the past five days even with the aid of cathartics. The distention increased and the patient vomited on the fourth and fifth day. With the onset there were griping abdominal pains.

Examination in the hospital showed a greatly distended abdomen, without tenderness or rigidity. No peristaltic waves were noted. The temperature, pulse and respiration were normal.

The patient was operated on for cancer of the sigmoid and an end to end anastomosis.

The patient recovered and was discharged.

The patient was operated on for cancer of the sigmoid and an end to end anastomosis.

The patient recovered and was discharged.

The patient was operated on for cancer of the sigmoid and an end to end anastomosis.

The patient recovered and was discharged.



temperature was  $36.6^{\circ}\text{C}$ ., pulse 70, red blood count 4,290,000 and white blood count 10,000.

Roentgen examination of the abdomen showed a distended colon proximal to the distal third of the transverse colon. At this point the colon could be faintly followed as a narrow,

CASE VII. J. Y., male, aged seventy-two, had episodes of abdominal distress for the past two years. He never had pain, but would vomit and have three or four light watery stools a day, following which he would feel well for a week or more. The food vomited would be that eaten

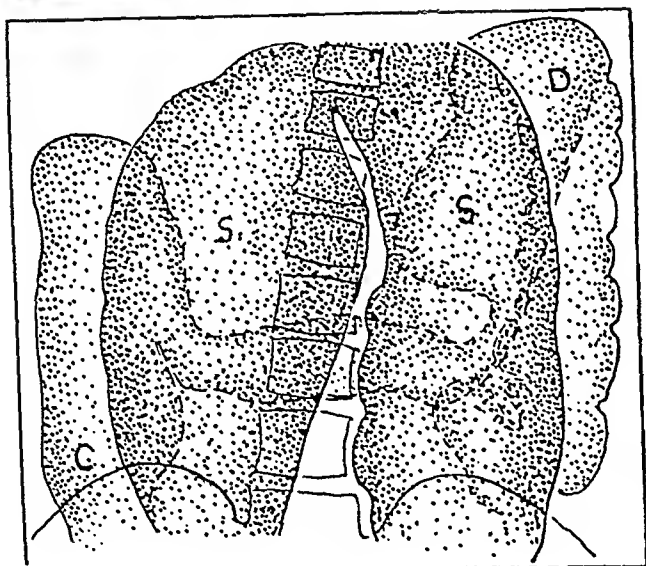
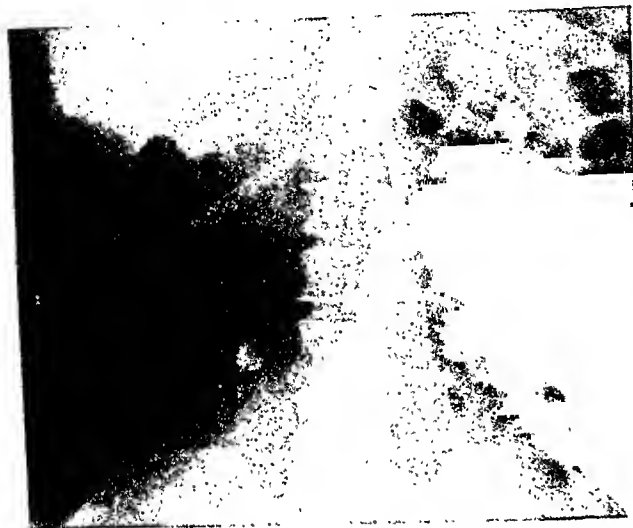


FIG. 8

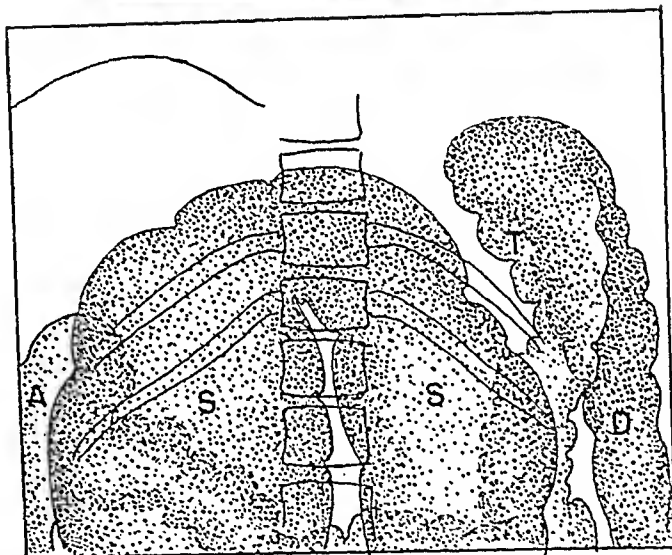


FIG. 9

FIG. 8 and 9. Case VIII. Volvulus of the sigmoid. The distended colon was so large that the entire bowel could not be demonstrated on one film. Figure 8, which missed the pelvis, shows a large loop of distended bowel rising out of the pelvis in the middle of the abdomen, extending towards the diaphragm. Moderately distended colon is seen behind the distended sigmoid loop. Figure 9 shows the upper end of this sigmoid loop with the sharp angulation between the ascending and descending limb. Diagnosis: Volvulus of sigmoid loop of colon with secondary distention of the colon proximal to the twist. *A*, ascending colon; *C*, cecum; *D*, descending colon; *S*, sigmoid.

funnel-shaped, gas-filled lumen gradually narrowing until finally occluded (Fig. 6).

A diagnosis was made of an annular constricting carcinoma obstructing the transverse colon.

At operation an adenocarcinoma was found in the mid-portion of the colon. The lesion was removed and a Mikulicz type of operation and anastomosis performed.

two to three days before. During the past two years he had lost 30 pounds.

Prior to admission to the hospital he had a gastrointestinal roentgen examination limited to the stomach, which was found to be normal. Examination in the hospital showed a dome-shaped abdomen, which was tense with a fullness present in the right side of the abdomen

To eliminate the possibility of a kidney tumor intravenous pyelography was done for which he entered the hospital. The temperature was  $36.2^{\circ}\text{C}$ ., pulse 90. Blood count was normal.

The intravenous pyelogram demonstrated normal kidneys but they showed a markedly distended cecum, ascending and transverse

ciated with constipation. Repeated cathartics of cascara, castor oil, and salts had no effect. For the past two days the pain was more severe and the abdomen showed increasing distention.

Upon admission to the hospital the patient showed a markedly distended abdomen, which was tympanitic, no palpable mass. Rectal exam-

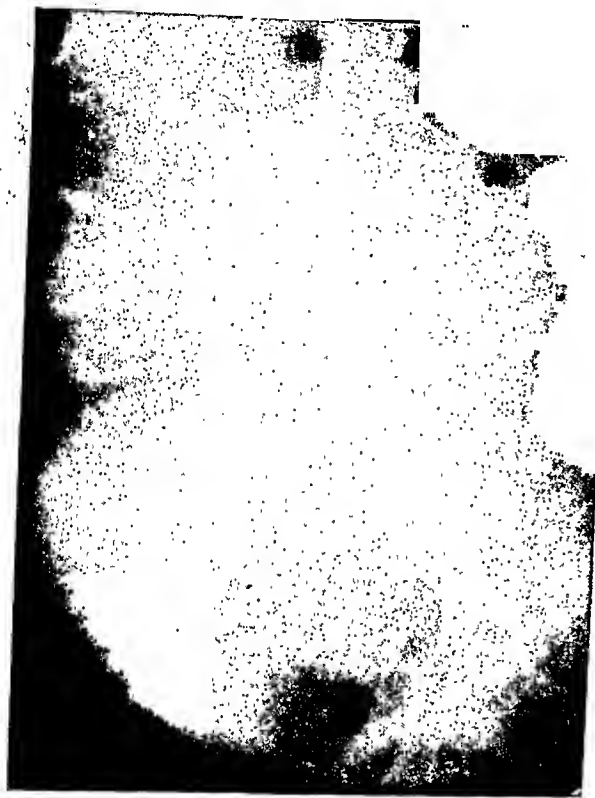
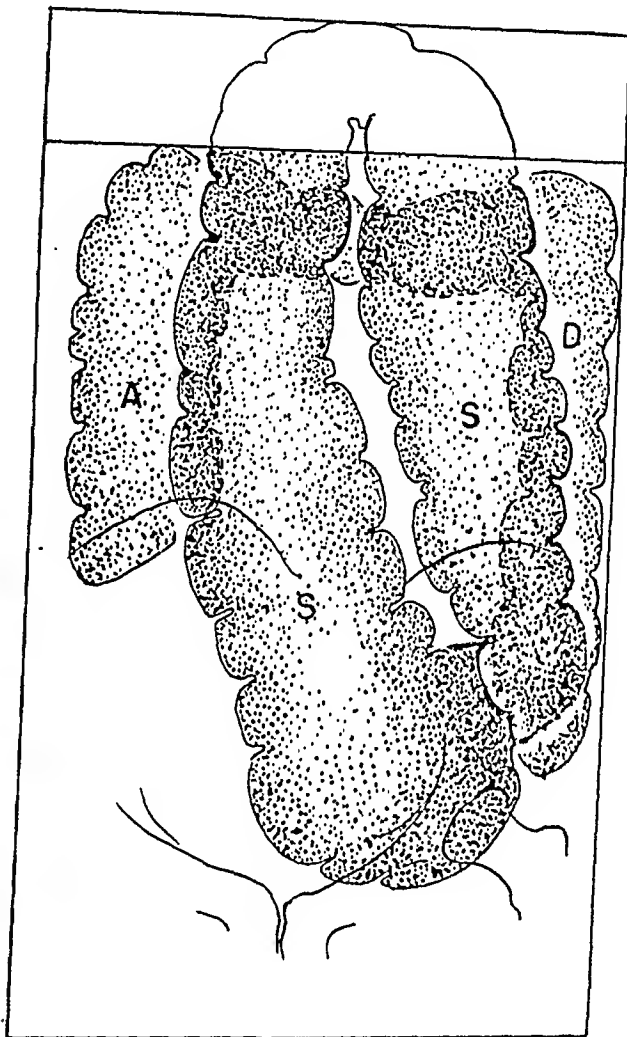


FIG. 10. Case ix. Volvulus of sigmoid. Tremendously dilated loop of bowel rising out of the pelvis and extending upward in the middle of the abdomen towards the diaphragm. The upper end of the bowel was cut off on the film and is diagrammatically presented. The colon proximal to this distended loop is also dilated, but not to the same degree. Diagnosis: Volvulus of the sigmoid. *A*, ascending colon; *D*, descending colon; *S*, sigmoid.



colon (Fig. 7). The cecum had some barium from the previous gastrointestinal examination. No gas was seen in the colon distal to the obstruction. A diagnosis was made of an obstructive lesion in the transverse colon, probably cancer.

A preliminary cecostomy was done, followed later by removal of an annular carcinoma 2 inches wide encircling the transverse colon.

CASE VIII. C. W., male, aged sixty-nine, had low abdominal pain for the past six days asso-

ciated with constipation. Temperature was  $37^{\circ}\text{C}$ ., pulse 82, respiration 20.

Roentgen examination of the abdomen showed a markedly distended loop of bowel rising out of the pelvis, extending to the diaphragm. Two films were necessary to take in the whole abdomen (Fig. 8 and 9). The distended loop was interpreted as a loop of sigmoid and a diagnosis was made of a volvulus of the sigmoid.

At operation free fluid was found in the abdomen. The diagnosis of a sigmoid volvulus

was confirmed. The bowel was drained, returned to the abdomen, but it resumed the old position of volvulus. The mesentery of the sigmoid was abnormally long. A colostomy was performed and subsequently the volvulus was reduced.

CASE IX. C. L., female, aged fifty-seven, had a previous history of carcinoma of the breast with multiple bone metastases. She had had increasing abdominal pain for the past three days, associated with a marked distention of the abdomen associated with constipation.

On admission to the hospital the abdomen was markedly distended. Temperature, pulse and respiration were normal. Rectal examination was normal. The red blood count was 3,000,000; white blood count, 10,000.

Roentgen examination of the abdomen showed a markedly distended loop of bowel rising out of the pelvis which was diagnosed as a volvulus of the sigmoid. The colon proximal to the volvulus was also distended (Fig. 10).

At operation the diagnosis was confirmed, the bowel was untwisted and a temporary colostomy performed.

#### SUMMARY AND CONCLUSIONS

1. Differential diagnosis between a slowly growing mechanical obstruction of the colon and an obstruction due to a sudden twist of the bowel as a volvulus can be made on a preliminary roentgenogram of the abdomen.

2. The slowly growing obstruction of the bowel is usually an annular carcinoma, non-fungating, cicatrizing in type. The bowel accommodates itself to the increasing obstruction by distending first in its thinnest part. This is the cecum. The entire bowel gradually becomes distended to the point of obstruction. The various parts of the colon can be delineated by the contrast of the gas in the preliminary roentgenogram. When the obstruction is complete the patient may present himself for the first time with symptoms of a lesion which has the nature of an acute obstruction of the bowel.

3. Volvulus of the sigmoid is a sudden obstruction. The involved loop of sigmoid becomes markedly distended. The distended sigmoid loop rises out of the pelvis

and lies in the mid-abdomen. It may extend to the diaphragm. It can be recognized as such on the preliminary roentgenogram.

4. Differential diagnosis between mechanical obstruction of the sigmoid and volvulus of the sigmoid is important since the surgical approach to the two conditions is different.

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## MECKEL'S DIVERTICULUM\*

By M. E. MOTTRAM, M.D.,\*\* and L. H. GARLAND, M.D.†

THE roentgen diagnosis of Meckel's diverticulum is rarely made preoperatively. The correct diagnosis of the anomaly is of considerable importance in cases of obscure abdominal pain and intestinal bleeding, especially since its surgical relief can often be fully assured. Additional cases correctly diagnosed prior to surgery would therefore seem to merit reporting.

The literature discloses reports of approximately 21 cases correctly diagnosed roentgenologically. Rousseau and Martin,<sup>13</sup> in 1943, collected 12 such cases† and added 1 of their own. In addition to these 13 cases, Conrad<sup>4</sup> and Ledoux<sup>7</sup> each reported 1 case; and Albright and Sprague<sup>1</sup> stated that, in a series of 22 cases of malignant disease involving Meckel's diverticulum, 6 cases had been demonstrated roentgenologically. These last mentioned authors did not publish any illustrations of their roentgenograms, but the other authors referred to did.

## ANATOMICAL CONSIDERATIONS

Meckel's diverticulum is an unobliterated remnant of the vitelline duct, the omphalomesenteric structure which connects the alimentary canal with the umbilical vesicle in the embryo. This duct normally disappears by the seventh week of fetal life, but may persist in part or in toto. It is usually thought of as connecting with the terminal ileum, but embryologically there is no valid reason why, if persistent, it may not be found almost anywhere along the middle two-thirds of the alimentary tract. Surgical reports indicate that such wide variations in location do exist.

When the entire vitelline duct persists it may do so as a fibrous band or as a tubular structure (forming an intestinal fistula). When the distal end alone persists, an um-

bilical sinus occurs; a persistent mid-portion will form an enterocystoma; a persistent proximal portion will constitute a Meckel's diverticulum or sac. Of these various possibilities, the persistent proximal portion (or Meckel's diverticulum) is the most common.

The diverticula vary widely in size, shape, location and anatomical structure. The size may vary from a tiny pouch to an enormous sac. The "usual" size reported at autopsy in uncomplicated cases is from 1 to 3.5 cm. in diameter (Noel<sup>9</sup>). In cases complicated by tumor, the reported size is almost invariably larger.

Moll<sup>8</sup> reported a case 82 cm. in length, described as virtually a "reduplication of the bowel!" Goldstein and Craig reported one 66 cm. in length; Chaffin<sup>3</sup> one 95 cm. in length in an eight year old child; and Pollard<sup>11</sup> one 90 cm. in length.

The most common point of origin is from the small bowel, usually the ileum about 37 cm. (15 inches) proximal to the ileocecal valve. However, it is often found anywhere from 3 to 100 cm. above that valve and it is stated that it may even arise from the colon. We have gained the impression that the ordinary asymptomatic cases tend to occur close to the ileocecal valve, while those with surgical complications are more apt to be 50 to 60 cm. (20 to 24 inches) proximal thereto. This impression is strengthened by the fact that anatomists usually describe the lesion as arising from the terminal ileum, while surgeons often place it at about 50 cm. above the ileocecal valve. It usually lies free on the antimesenteric border of the bowel, but may vary in its point of origin, and even have its own mesentery. It may be considerably distorted in shape owing to the presence of adhesions, secondary infection or tumor.

The diverticulum may have walls iden-

† Including those of Case<sup>2</sup> and Farr and Penke<sup>4</sup>

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FIG. 1

FIG. 2

FIG. 1 and 2. Fig. 1. Meckel's diverticulum. Six hour roentgenogram at time of initial examination. Note collection of opaque material overlying the left side of the lower lumbar spine. Roentgenoscopic survey prior to ingestion of the barium disclosed no such opacity (thereby excluding a calcifying mesenteric cystic lesion or prior medicinal material in the bowel). Note that there is no significant stasis proximal to the diverticulum and that the adjacent loops of ileum are not dilated.

Fig. 2. Same as Figure 1, with arrows pointing to the margins of the sac and, at its inferomesial edge, the neck of the sac. The barium is obviously diluted with non-opaque material, presumably present in the sac prior to the roentgen examination. Subsequent operation disclosed this sac to be about 7 cm. in diameter, located about 60 cm. proximal to the ileocecal valve, and partly filled with purulent material.

tical in structure with those of the adjacent intestine, or one of the muscle layers may be absent. Heterotopic gastric or duodenal glands may be present. Neoplastic alteration is not uncommon.

#### INCIDENCE

The incidence of Meckel's diverticulum in the general population, at autopsy, is about 2 per cent. Of those so affected, Wilson<sup>13</sup> estimated that about 20 per cent will develop symptoms or complications, leading to its diagnosis, usually at operation.

#### COMPLICATIONS

Normally, the majority of cases of Meckel's diverticulum are asymptomatic and uncomplicated. A small number devel-

op intestinal obstruction (with or without intussusception<sup>12</sup>); diverticulitis (with or without perforation); ulceration (with perforation or hemorrhage); foreign body inclusion; or malignant degeneration.<sup>14</sup>

If the diverticulum has walls deficient in one or more of the muscle layers, stasis tends to occur. If gastric mucosa is present, peptic ulceration may develop, either in the diverticulum itself or in the adjacent ileum; secondary intestinal bleeding may then occur.

#### DIAGNOSIS

The diagnosis can often be suspected and occasionally made on clinical grounds alone. Symptoms of intermittent mid or lower abdominal pain, with or without



FIG. 3. Meckel's diverticulum. Roentgenogram made two and a half hours after oral ingestion of barium water. Note ovoid opacity (barium-filled diverticulum) overlying the lumbosacral angle.

tarry stools, may suggest diverticulitis or ulceration in a Meckel's sac, especially when occurring in individuals under thirty-five years of age. Intermittent intestinal bleeding without symptoms or signs of peptic ulcer, intestinal tumor or colonic disease may also lead to suspicion of the lesion.

Roentgen examination of the alimentary tract will only rarely establish the presence of the condition, but the recorded cases, including that reported herewith, demonstrate the fact that such diagnosis is occasionally possible. We doubt if the small (2.5 cm. diameter) diverticulum can be diagnosed, except fortuitously. The larger diverticula, especially those with abnormal or inflamed walls and therefore with stiffness, should be detected on careful gastrointestinal examination.

Gastrointestinal study with small water-

barium meals (up to 8 ounces volume) will reveal a collection of barium in the mid or lower abdomen, which does not conform to the shape or appearance of the normal loops of small bowel. This collection of barium will vary in density during a twenty-four hour period according to its degree of dilution with intestinal contents. It may not be demonstrable at times, presumably owing to prior filling of the sac with intestinal contents. Pfahler<sup>12</sup> reported 1 case in which the diverticulum filled only in the prone position. Ehrenpreis suggested that a lateral projection would aid in diagnosis, because of pointing of the diverticulum towards the umbilicus. This might aid in the case of a very large diverticulum, but the unavoidable overlapping of adjacent, filled, small bowel loops would render accurate delineation very difficult. Further, the marked variation in the direction of most diverticula would probably render the view of little or no value.



FIG. 4. Meckel's diverticulum. Roentgenogram made two and a half hours after oral ingestion of barium water. Note small, dark, rounded opacity (barium-filled diverticulum) overlying the lumbosacral angle.



The following case showed an encapsulated collection of barium connected with the lower ileum and persisting for twenty-four hours:

G. W. C., a male Hawaiian aged thirty (referred by Dr. J. Tobin to Dr. M. E. Mottram for gastrointestinal study). The patient gave a history of steady epigastric and periumbilical pain, of several hours' duration. The pain came on suddenly and gradually extended to the lower abdomen. There was nausea but no vomiting. The patient was admitted to the hospital, the pain subsiding on entry, leaving generalized abdominal tenderness. Prior to this attack there had been milder bouts of abdominal pain and gaseous distention for a period of one year.

On examination in the hospital, the patient had periumbilical and left lower quadrant tenderness, with moderate muscle spasm, but no rebound tenderness. Peristalsis appeared to be decreased. His temperature was normal (but rose slightly next day to 99.8° F.). The white blood count was 18,150 with 87 per cent polymorphonuclear cells; next day it was 13,300, with 72 per cent polymorphonuclears. No stool examination was done.

*Roentgen Examination.* Preliminary roentgenoscopic survey of the abdomen was negative. The esophagus, stomach, and duodenum appeared normal. At six hours, a collection of barium was noted in the mid-abdominal area, apparently in a pocket or sac near the umbilicus. Re-examination next day confirmed the presence of this sac-like structure, which had then changed in size. It measured about 9 by 5 cm. in the posteroanterior projection, was poorly movable and slightly tender. It retained some barium for over twenty-four hours. There was no small bowel obstruction. The appendix filled, was movable and not tender. The colon appeared negative. A diagnosis of probable Meckel's diverticulum was made.

Surgical intervention was decided upon by Drs. Curtis Smith and J. Tobin. At operation a large, circular diverticulum, measuring about 7 cm. in diameter was found attached to the ileum about 60 cm. (24 inches) proximal to the cecum. Its neck was about 2.5 cm. in diameter and it had a short mesentery. Its external surface was red and granular, and some loops of small bowel were lightly adherent to its apex. The diverticulum was removed; it weighed 126 grams and contained intestinal contents, thick purulent material and barium. The stump was inverted and the abdomen closed. The patient made an uneventful recovery.



FIG. 5. Meckel's diverticulum. Roentgenogram made twenty-four hours after barium by mouth. The sac remains filled with diluted barium. The small bowel loops are empty. The appendix is filled and displaced slightly cephalad by the sac. A little barium remains in the colon, chiefly in the rectum.

#### SUMMARY

1. Meckel's diverticulum occurs in about 2 per cent of the population. It varies greatly in size, shape, and location. The larger diverticula apparently tend to produce symptoms, principally those of intestinal bleeding, attacks of colicky pain localized about the umbilicus, and vomiting.
2. The diverticulum frequently occurs at a greater distance proximal to the ileocecal valve than is thought probable (e.g. a distance of 60 cm. as in the case reported herewith).
3. The finding of a collection of barium in the mid or lower ileal area, which fails to conform to the usual pattern of the small bowel or which persists after the small bowel is empty should suggest the possibility of the lesion.
4. Most of the reported cases of Meckel's diverticulum diagnosed roentgenologically

have been of fairly large size, or have been suspected clinically and carefully searched for. Some of them have been associated with ulceration, obstruction or tumefaction.

5. The lack of uniformity in the location and size of the diverticulum, and the fact that at times it is filled with non-opaque material may render the roentgen diagnosis very difficult.

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## PERIOSTEAL LESIONS IN SCURVY\*

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THE important developments in the history of scurvy are the accurate comprehensive description of the cause, symptomatology, pathology and cure of the disease in adults by James Lind, the English naval surgeon, in 1747, and the recognition of infantile scurvy, formerly called acute rickets, by Thomas Barlow<sup>1</sup>

adult scurvy and that they *caused* a disturbance in the growth process at the ends of the long bones leading to epiphyseal separation and displacement. Epiphyseal separation had been described by Lind<sup>9</sup> as follows: "All young persons under 18 had in some degree their epiphyses separated from the body of the bone," but the simi-

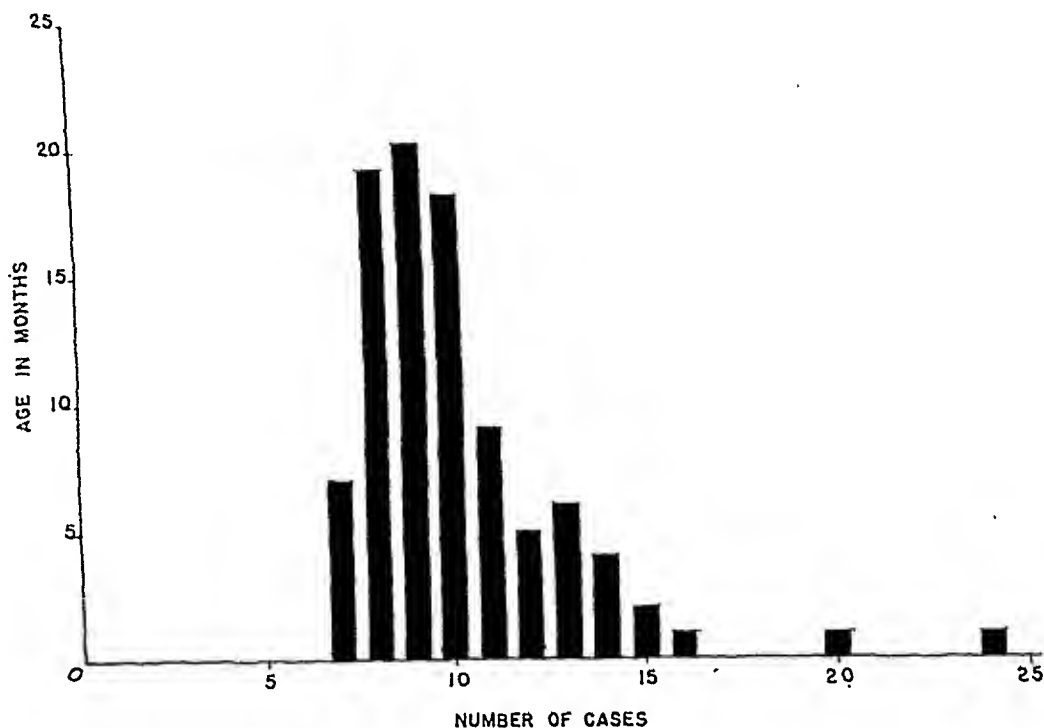


FIG. 1. Age incidence in 93 cases of infantile scurvy, 1936-1941.

and a group of English pediatricians toward the end of the nineteenth century. The disease had undoubtedly become more prevalent at that time from the use of antiseptic and artificial methods of infant feeding, and Barlow was able to report his findings in 39 fatal cases. He was impressed by the frequency and severity of the subperiosteal hemorrhages occurring usually in the long bones, but rarely also in the flat bones such as the scapula and in the bones of the cranial vault and the orbits. It was Barlow's conception that the subperiosteal hemorrhages were analogous to the hemorrhages seen in the gums and in the skin of

larly to the epiphyseal separation of infantile scurvy was not recognized until much later. It is important to recall that Barlow's studies were made on fatal cases and were therefore concerned only with cases where the disease was very severe and far advanced. Apparently no attempts were made to study the development of scurvy experimentally in animals at that time. The early bone changes in infants were, however, studied a little later by means of the recently discovered roentgen ray, notably in the hands of Fraenkel<sup>8</sup> whose name has been given to the dense metaphyseal line which he emphasized as an important

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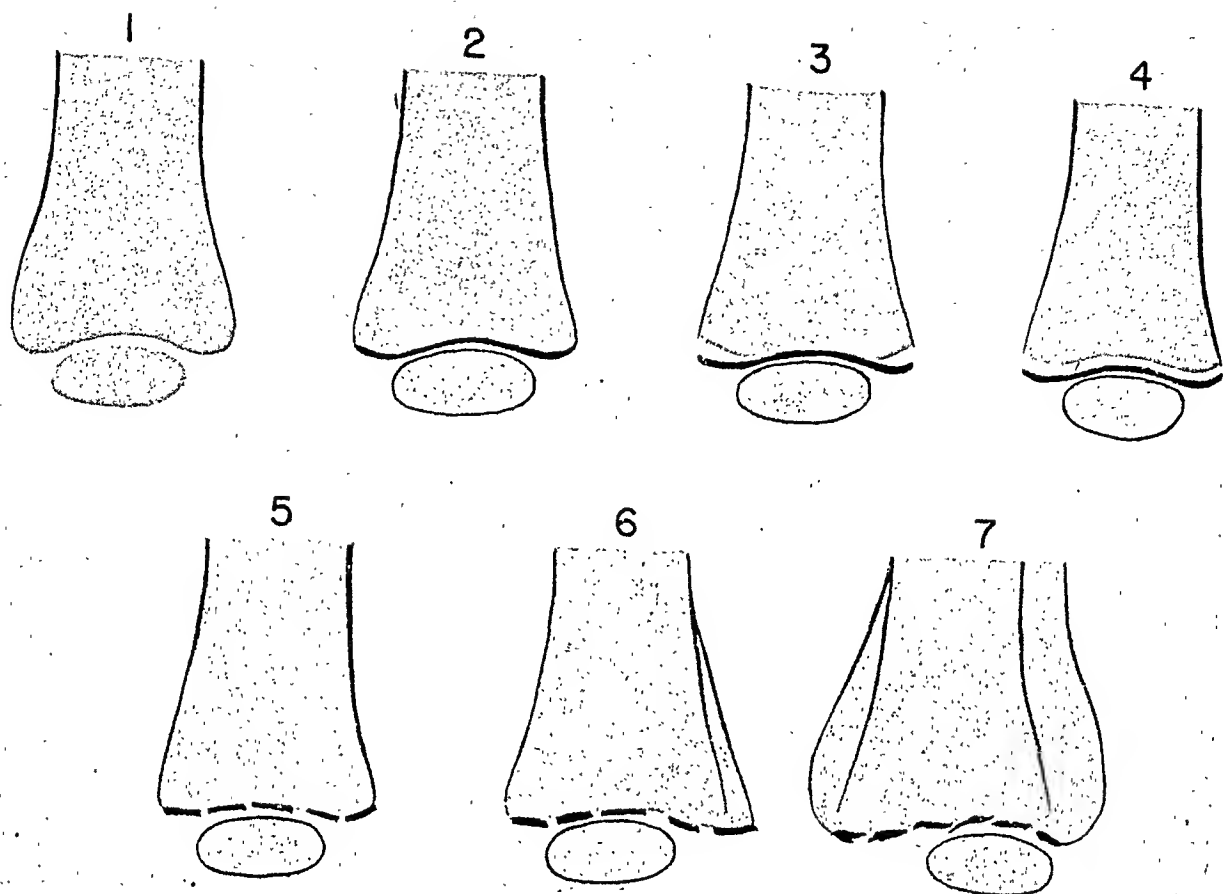


FIG. 2. A diagrammatic representation of the development of the osseous changes in scurvy. 1, normal growing bone; 2, increased width and density of the metaphysis, signet ring appearance of the epiphysis and a ground glass type of demineralization; 3, submetaphyseal notching representing minute fractures of newly formed bony trabeculae; 4, extension of the notching and separation of the metaphysis; 5, fragmentation of the metaphysis; 6, lateral displacement of a small metaphyseal fragment lifting the periosteum and causing subperiosteal hemorrhage Type I; 7, further disintegration of the metaphysis permitting lateral displacement of the epiphysis and massive subperiosteal hemorrhage Type II.

sign of scurvy. Wimberger<sup>15</sup> saw a large number of cases in Vienna following the first World War and described the signet ring appearance of the epiphyses which has since been referred to by his name. By using refinements in roentgen technique and the correlation with animal experiments, the finer details of the metaphyseal changes in scurvy were worked out by Pelkan,<sup>14</sup> Bromer,<sup>4</sup> and Park *et al.*<sup>13</sup> It has gradually become evident that subperiosteal hemorrhages are only a late manifestation of scurvy and that the earliest osseous changes occur in the metaphyses. Although most close students of the subject agree on this point, the misconception is still prevalent that periosteal lesions are a prominent feature in the diagnosis and pathology of scurvy. Park and his associates in 1935

stated: "Subperiosteal hemorrhages develop only when the involvement of bone has reached an advanced stage. They are the result of the fractures of the cortex and lattice at the end of the shaft," and more recently in 1940: "The fractures of the lattice cause the characteristic extravasations of fibrin and sometimes hemorrhage." "The giving way of the lattice causes the cortex to break, the blood vessels of the periosteum to be torn, and blood to leak under the periosteum."

For the purpose of studying the correlation of the metaphyseal and periosteal lesions in scurvy as revealed roentgenographically, the roentgenograms were reviewed where a diagnosis of scurvy had been made at the Children's Hospital of Michigan during the years 1936-1941. Dur-

ing this six year period in a hospital service comprising 106,800 new out-patient visits and 41,773 hospital admissions, 93 cases were encountered indicating that even in these days of vitamin consciousness infantile scurvy is by no means a rare disease.

The sex distribution was about equal, comprising 48 males and 45 females.

The age incidence revealed a pronounced limitation of cases to the latter half of the first year of life. No cases were observed before the seventh month and 90 per cent fell in the ages from seven to thirteen months inclusive (Fig. 1). This corresponds well with the age incidence observed by McLean and McIntosh.<sup>10</sup>

All of the cases were tabulated with designations to indicate the presence and

extent of the various osseous manifestations of scurvy revealed in the roentgenograms. The roentgenograms routinely comprised single anteroposterior views of both arms and legs. Examinations were often repeated a few weeks following the institution of treatment to follow the progress of the lesions. The most advanced lesions were usually seen in the knees, followed by the shoulder and ankle joints, and then by the wrist, hips and elbow joints in that order. The progression of lesions as the disease becomes more severe is represented schematically in Figure 2.

The earliest changes represented by the ground glass type of demineralization of the bone structure and by the signet ring appearance of the epiphyses are seen with

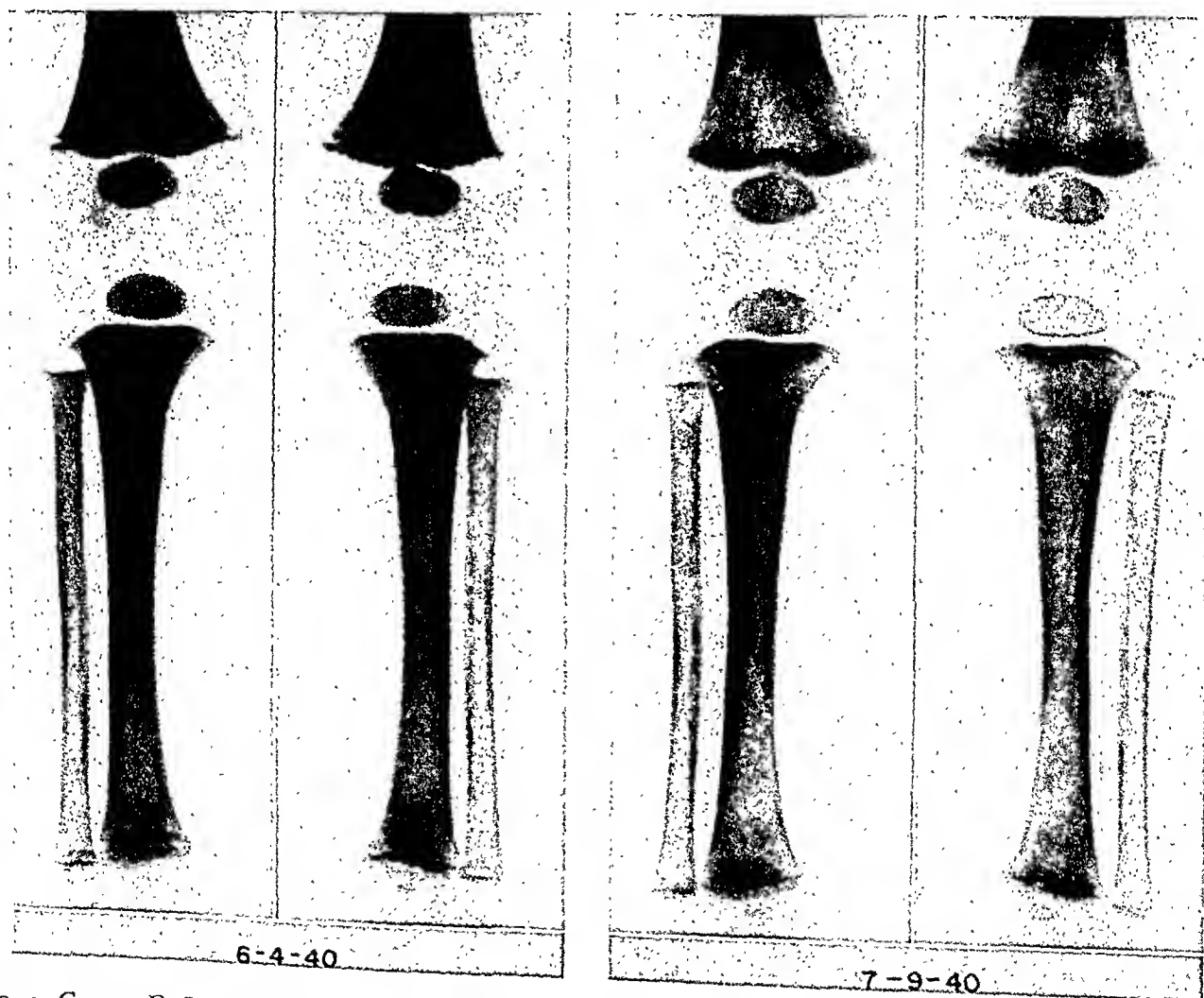


FIG. 3. Case 1. E. L. (CHM No. F3803). Well marked clinical and roentgen evidence of scurvy in a male infant, aged eight months. The metaphyseal lines are broad and dense, and there is well defined subperiosteal new bone formation especially in the lower ends of the femurs, but no metaphyseal fragmentation or displacement. Re-examination five weeks later following administration of cevitamic acid shows complete healing with no sign of a periosteal hemorrhage.

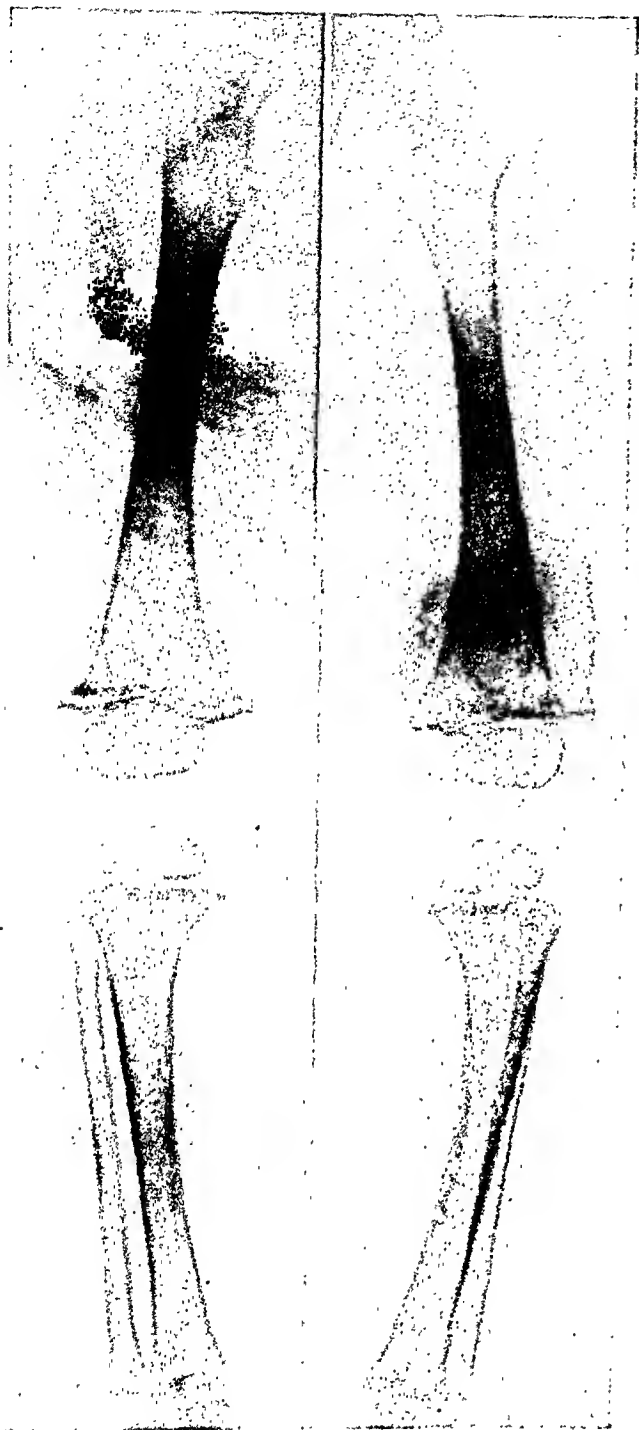


FIG. 4. Case 11. L. O. (CHM No. G6913). A nine month old white female fed by formula and without orange juice or other antiscorbutic. Metaphyseal changes in the tibiae are minimal and no periosteal shadows are seen. Well marked scorbutic changes are seen in the lower femoral metaphyses. On the right there is only slight lateral extrusion of the metaphyseal fragments and there are Type I periosteal shadows, while on the left the metaphyseal extrusion is more marked and there has been some lateral displacement of the epiphysis as well. Here there is the Type II subperiosteal hemorrhage.

great frequency but are not, we think, of sufficient specificity to be regarded as pathognomonic of scurvy. The signet ring appearance was most pronounced in the epiphyses at the knee joints and was present in the same degree in all of the cases. The ground glass appearance, on the other hand, was seen less constantly (74 per cent) and was absent particularly in those cases complicated by rickets.

The submetaphyseal notch, emphasized by Park and his colleagues as the earliest pathognomonic sign of scurvy in the roentgen examination, was observed in 89 per cent of the 93 cases. In other cases it was doubtful, in some instances being masked by rickets. The metaphysis was found fragmented or separated in 42 per cent of the cases, and there was actual displacement of the metaphysis or a large portion of it carrying with it the epiphysis in 19 per cent.

Particular attention was paid to the character of the periosteal shadows and their association with the metaphyseal changes. Periosteal shadows in scurvy were observed to be of two types. The first, referred to as Type I, appears as a narrow triangular shadow having its base at the metaphysis and extending from there for some distance along the shaft. This type was not seen when there was only the submetaphyseal notch but first when there was some fragmentation of the metaphysis and a slight lateral displacement of a small marginal fragment at the lateral or medial aspect. This type of periosteal shadow was observed in 39 per cent of the cases.

The second type of periosteal shadow (Type II) is very much larger, is usually club shaped and extends along the greater length of the shaft. It is quite constantly associated with displacement of a large portion of the metaphysis and the epiphysis as well. This circumstance was observed in 17 per cent of the cases.

Plausible explanations are available for a small discrepancy which exists between these actual observations and this hypothetical association of metaphyseal and



periosteal lesions. As Nelson, Doughty and Mitchell<sup>12</sup> and others have pointed out, the periosteal hemorrhages only become demonstrable on the roentgenogram when calcification begins to take place. Calcification does occur after a very short interval but there is nevertheless a period when the circumstances for a subperiosteal hemorrhage may be present and the hemorrhage not be demonstrable for want of calcification. This is not a common occurrence and is obviated if serial studies are made, as they were frequently in this review. When a large subperiosteal hemorrhage is present, the displacement of the epiphysis may not be evident in the plane in which the roentgen exposure was made. One of the most common sites of epiphyseal displacement is at the lower end of the femur. The displacement occurs lateralward and if the examination is made with the child on his back and the legs in external rotation and some abduction, lateral views will be obtained of the knees and the lateral displacement of the epiphysis will be missed. This position is the most comfortable for the scorbutic infant who resents manipulation and was commonly used in the early studies. Epiphyseal displacement may also be missed because it is not present at the moment the study is made. It is well known that when epiphyseal displacement has occurred the epiphyses are quite freely mobile, and it is readily understandable that the epiphysis may by chance be in a normal position when there has recently been a marked displacement and a large subperiosteal hemorrhage. This circumstance was observed in one case in this series.

#### DIFFERENTIAL DIAGNOSIS OF PERIOSTEAL CHANGES MANIFESTED ROENTGENO- GRAPHICALLY IN INFANCY

The periosteal areas rival the metaphyseal regions in the variety and striking character of the changes which occur in infancy during the period of most rapid growth. The number of diseases with great variations in their prognosis and indica-

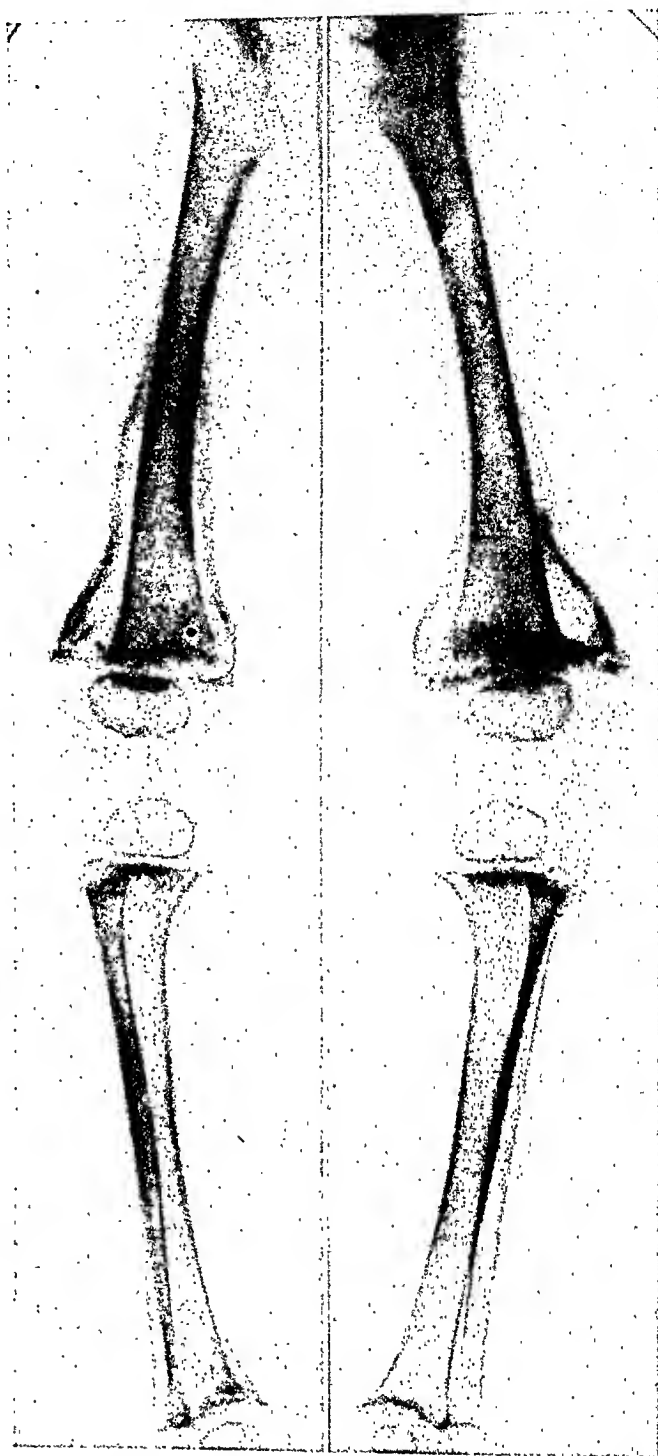


FIG. 5. Case III. B. B. (CHM No. G3657). A ten month old white female infant fed by formula and canned orange juice. Cod-liver oil had been adequate. The most advanced scorbutic changes are seen in the lower ends of the femurs where there has been complete disintegration of the metaphyses with lateral displacement of the epiphyses and Type II periosteal shadows. Lesser changes are seen in the tibiae but with some medial extrusion of metaphyseal fragments and a Type I periosteal shadow at the lower end of the right tibia.

tions for treatment which are associated with periosteal manifestations calls for a close interpretation and analysis.

*Rickets.* It is often difficult to identify minor degrees of rickets and scurvy when both diseases are present together. Some degree of rickets was thought to be present in 36 of the 93 cases in this series. At times, lesions characteristic of scurvy may be seen in the metaphysis of one bone and those of

curs at a greater distance from the epiphyseal line and is less sharply defined. The periosteal manifestations may also provide distinguishing features. While in scurvy the periosteal shadows originate in the metaphyseal areas, are usually widest there and tend to have a uniform density with a sharp outline, the periosteal shadows of rickets occur about the middle third of the shaft and are laminated. The periosteal lesions of rickets are most pronounced in the first six months of life and are much less frequently seen in the age period when scurvy is prone to occur.

Periosteal shadows of unknown etiology such as those reported as occurring especially in early infancy<sup>11</sup> resemble the periosteal shadows of rickets and are easily differentiated from scurvy. In our experience, minor degrees of this periosteal manifestation are seen frequently. The shadows disappear in the course of a few weeks by incorporation into the cortex and do not seem to be of any clinical or pathological significance.

*Infection.* In infancy the bones frequently become involved in a variety of infections with prominent periosteal as well as osseous lesions. The lesions of syphilis, tuberculosis, and pyogenic osteomyelitis in general offer no roentgenologic problem in differentiation from scurvy. Clinically, however, scurvy is occasionally mistaken for osteomyelitis and there seems to be at least one published case where the periosteal proliferation and involucrum of osteomyelitis were mistaken for an ossifying subperiosteal hemorrhage of scorbutic origin. In the case reported by Benninghoven<sup>3</sup> the ulna of a ten month old infant was enveloped in a dense irregular periosteal proliferation such as is commonly seen in the osteomyelitis of infancy. I have not encountered an instance of scorbutic subperiosteal hemorrhage involving the ulna either in my immediate experience or in a perusal of the literature, and it seems very unlikely that such would occur inasmuch as the metaphyseal lesions of scurvy are minimal in the ulna and the ulnar epiphyses

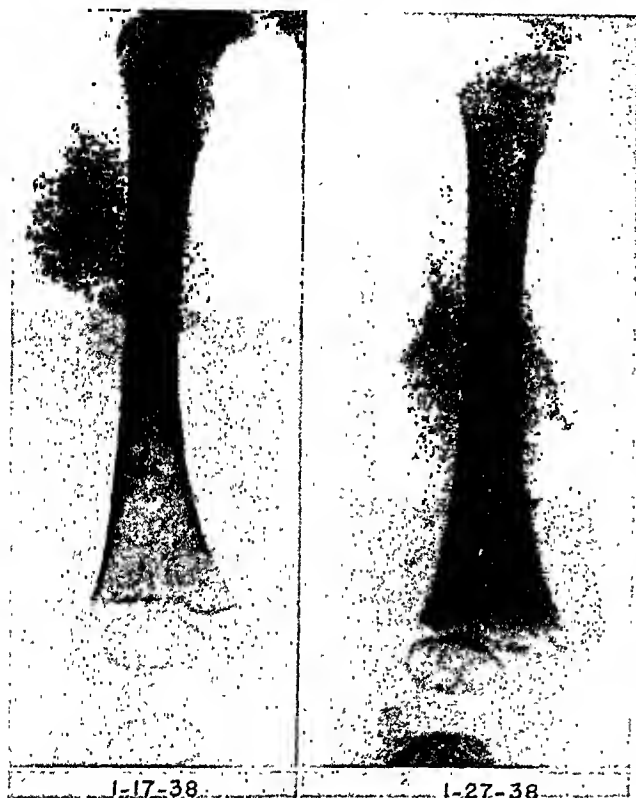


FIG. 6. Case IV. M. S. (CHM No. D527). A one year old white male infant fed by cow's milk with no cereals or vegetables and no cod-liver oil or orange juice. The first study shows disintegration of the lower femoral metaphysis especially at the lateral aspects with some lateral extrusion of metaphyseal fragments and a signet ring appearance of the femoral epiphysis, characteristic of scurvy. At the second study ten days later there has been displacement of the epiphysis and formation of a large subperiosteal hematoma Type II.

rickets in another as in Case VIII. Rachitic changes are apt to be most pronounced in the distal ulnar metaphysis, while the distal radial metaphysis seems to be more prone to the development of a scorbutic lesion. When the manifestations occur together, as at the knee, the metaphysis is wider and with a more frayed irregular structure of lower density than when scurvy is present alone. Also the submetaphyseal notch oc-

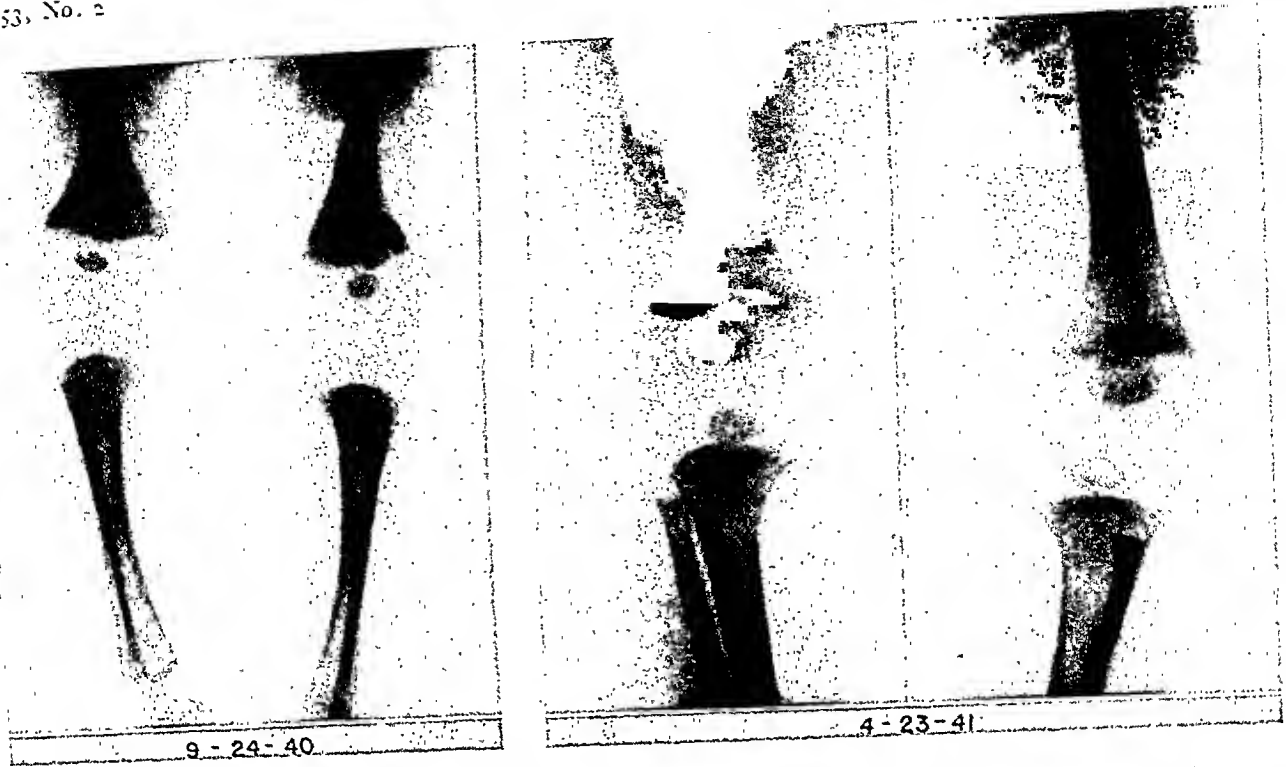


FIG. 7. Case v. H. R. A private patient of Dr. S. Bernstein, born about three weeks premature on August 22, 1940, of a difficult breech delivery. The legs were observed to be swollen and tender with mobility limited at the knees. The roentgen studies revealed a bilateral lateral dislocation of the distal femoral epiphyses and ossifying subperiosteal hemorrhages. Development and growth were very satisfactory, and the study at eight months shows no residual deformity.



FIG. 8. Case vi. T. S. (CHM No. G7140). An eight week old infant admitted to the hospital with a story of multiple abscesses in the skin for two weeks. The tuberculin skin test and the serological tests for syphilis were negative. *Staphylococcus aureus* was obtained by blood culture. Treatment consisted in large doses of sulfadiazine and transfusions of blood. One of the sites of abscess formation was in the right knee, and the roentgenograms show the development of an osteomyelitis of the tibia with displacement of the proximal tibial epiphysis and extensive periosteal formation of new bone.



FIG. 9. Case VII. L. S. (CHM No. C7211). An eleven month old colored child with a long history of respiratory infection, diarrhea and feeding problems, and with an uncertain irregular intake of cod-liver oil and orange juice. There are the coarse trabecular markings, the laminated periosteal and cortical shadows in the shafts of the long bones characteristic of rickets. In addition there are sub-metaphyseal notchings (lower medial aspect of the left femur) and Type 1 periosteal shadows indicative of scurvy with early subperiosteal hemorrhage.

are undeveloped in infancy. My diagnosis of scurvy was based upon the finding of some blood by aspiration and a low vitamin

C content of the blood. Both of these findings are quite compatible with osteomyelitis without scurvy. Benninghoven's opinion that subperiosteal calcification may precede typical scurvy changes in the diaphyses of the long bones is contrary to the experience of other observers.

In one case of this series (Case VI) there was a closer similarity to scurvy in that the ossifying periostitis was accompanied by epiphyseal displacement. The irregular density and contour of the periosteal shad-



FIG. 10. Case VIII. M. S. (CHM No. F3797). An eight month old white infant who had never been given orange juice or other antiscorbutic, and cod-liver oil only at irregular intervals. In the wrists the metaphyseal line at the lower end of the radius is dense and there is sub-metaphyseal notching characteristic of scurvy, while the flaring and cupping in the ulnar metaphyses indicate rickets.

ow is quite unlike that seen in scurvy, however. The destructive lesions in the bone itself as well as in bones elsewhere in the body, and the absence of any changes resembling scurvy in the metaphyses leave no doubt concerning the roentgen diagnosis of pyogenic osteomyelitis.

*Trauma.* Traumatic displacement of an epiphysis results in separation of the periosteum at the end of the shaft and subperiosteal hemorrhage not unlike that seen with the epiphyseal displacement of advanced scurvy and this lends some support to the view that the mechanism of the subperiosteal hemorrhage is the same in both instances. Epiphyseal displacements in infancy are usually the result of birth trauma and we have seen instances of subperiosteal hemorrhage apparently resulting from displacement of unossified proximal humeral

and femoral epiphyses. One instance, however, where the lower femoral epiphysis was displaced shows more clearly the relation of the epiphyseal displacement to the subperiosteal hemorrhage (Case v). It is true that the hemorrhage is not as profuse or

extensive as that seen in scurvy, but there is, we think, an essential similarity in the manner by which the hemorrhage is pro-

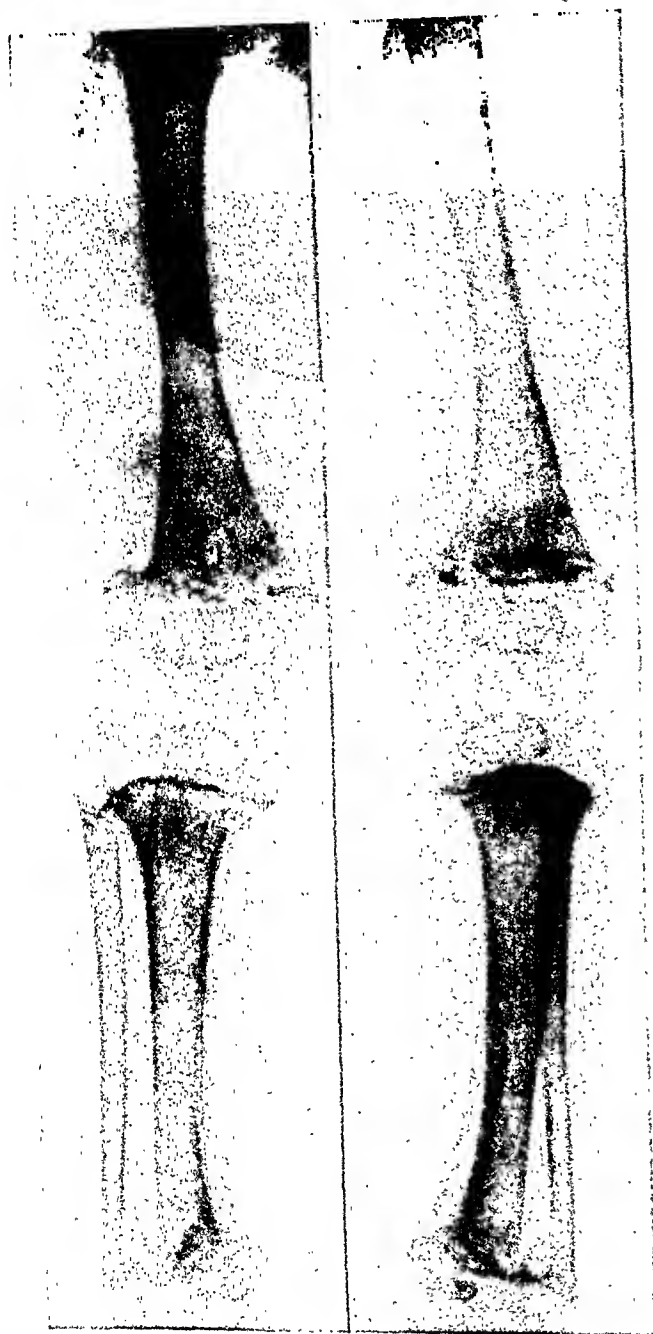


FIG. 11. Case ix. C. C. (CHM No. B7407). A nine month old white female nourished by formula feeding with no orange juice or cod-liver oil for four months and very small amounts before that. Advanced rachitic and scorbutic changes are seen in the metaphyses. There are laminated periosteal shadows of the rachitic type at the medial aspect of the tibial shafts, together with subperiosteal hemorrhages secondary to the scorbutic fragmentation, disintegration and displacement of the metaphyses.



FIG. 12. Case x. F. D. (CHM No. F7952). Skeletal changes observed in a colored child, aged two, suffering from lymphatic leukemia with fever, malaise, and pains in the legs. The tuberculin skin tests were negative, as were the Kline and Kahn serological tests for syphilis. At the time of this study no abnormality could be detected in the blood other than a slight anemia. The leukemic picture appeared terminally seven weeks later and the diagnosis was confirmed at autopsy. The roentgen findings have certain resemblances to scurvy. The periosteal shadows occur away from the metaphysis, however, and there is infiltration of the underlying bone. The metaphyseal line is of increased width and density and there is sub-metaphyseal rarefaction, but without the notch representing minute fractures of the trabeculae seen in scurvy.

duced. As in scurvy, there is amazingly little disturbance in the subsequent growth of the bone and no residual deformity or disability.

*Neoplasm.* Neoplastic infiltration, es-

pecially that of leukemia and neuroblastoma, may produce a picture similar to that of scurvy (Case x). A dense metaphyseal line with submetaphyseal rarefaction commonly occurs in leukemia as described by Baty and Vogt.<sup>2</sup> In scurvy the line is more sharp and dense, however, offering a greater contrast to the uniformly demineralized bone of the diaphysis. Also the submetaphyseal notch is recognizable as a distinct fracture rather than a band of demineralization such as occurs in leukemia. Subperiosteal leukemic deposits tend to occur about the mid-portions of the shafts of the long bones rather than in the metaphyseal areas and there is apt to be a recognizable infiltration or destruction in the underlying bone, as in Case x.

#### CONCLUSIONS

There is a close correlation between the clinical and roentgenological diagnosis of infantile scurvy. Pathognomonic signs are almost always demonstrable in roentgenograms made when the child is first seen in the clinic.

Infantile scurvy is still a common disease in hospital practice. It occurs almost exclusively in the narrow age range of seven to fifteen months.

The periosteal lesions of scurvy depend for their occurrence, location, and severity upon the severity of the lesions which develop in the metaphyseal areas of the long bones.

The differential diagnosis of scorbutic periosteal lesions from the periosteal lesions of rickets, infection, trauma and neoplasm is usually not difficult.

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# ROENTGENOGRAPHIC DEMONSTRATION BY TANTALUM POWDER OF SINUSES RESULTING FROM EXTRACTION OF INTERVERTEBRAL DISC PROTRUSIONS\*

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IN 1939 we began implanting a silver hemostatic clip as deeply as possible into the sinuses resulting from the protrusion of intervertebral discs, as Barr<sup>1</sup> had suggested

curettage of all easily removable fragments, in several cases the sinus was filled with lipiodol or with a colloidal suspension of thorium dioxide (thorotrast), the excess of

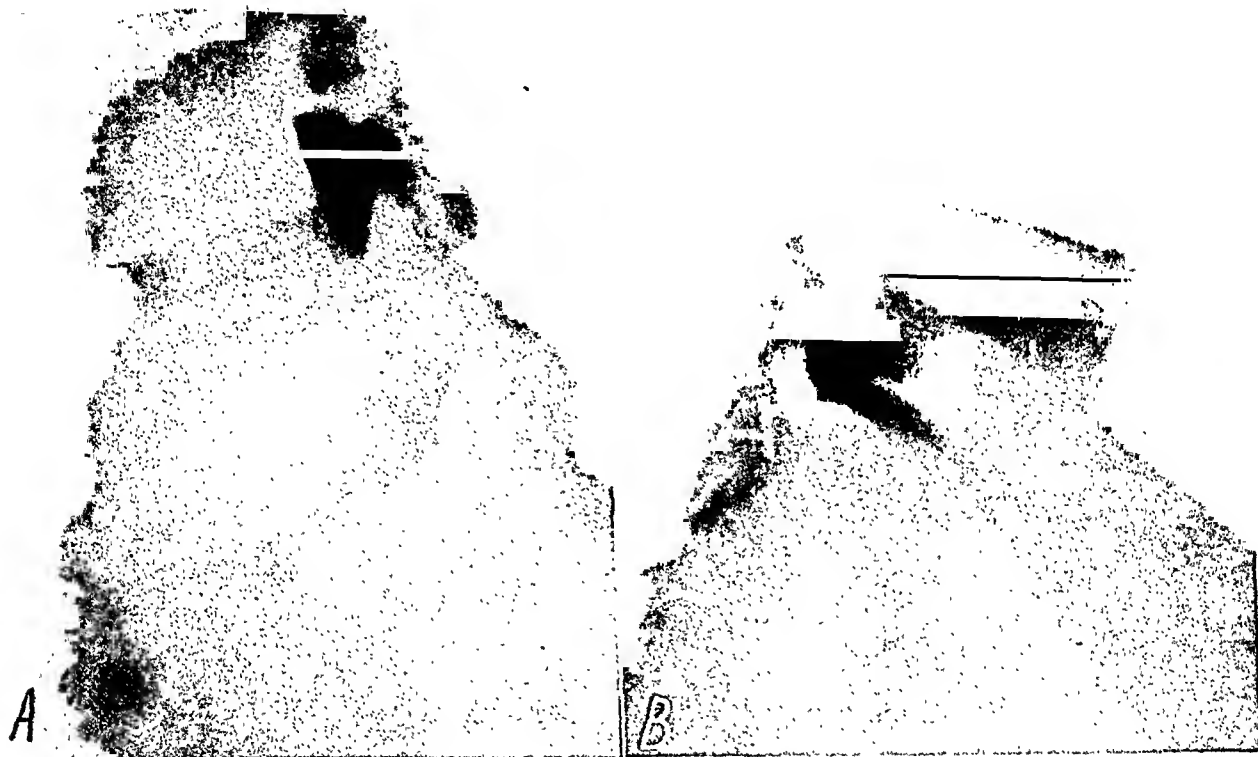


FIG. 1. Displacement of silver clip from disc sinus by recurrent disc protrusion. *A*, clip placed in sinus after removing protruded portions. *B*, displacement of clip upon recurrence of symptoms. Recurrence of protrusion confirmed surgically.

two years earlier. This served to identify the level of the lesion accurately by roentgenography when the operation was done without the removal of bone and to confirm possible recurrence by displacement of the clip (Fig. 1). The blind closure of the clip in the sinus cannot insure that it is attached to residual disc material, so its subsequent displacement is not specific in meaning.

Attempting to visualize the postoperative alterations in the disc sinus following

which was removed by suction. Not enough of the material adhered to the sinus walls for satisfactory roentgenograms. Sterile tantalum powder† then was tried for this purpose. We know of no previous use of tantalum powder as a contrast medium in the body, but we have used it also to demonstrate the extent of the incisions in prefrontal lobotomy. One curette cup (6 by 4

† Supplied by Mr. I. R. McCall, Fansteel Metallurgical Corporation, Chicago, Illinois.

\* From the Buffalo General Hospital and University of Buffalo School of Medicine.



FIG. 2. Disc sinus demonstrated by tantalum powder, ten days after operation.

by 2 mm.) full of the powder is introduced into the disc sinus, being careful to allow none to come into contact with the tissues of the spinal canal. With the curette, it is dispersed as widely as possible within the disc. At present, double this amount of powder is used, since the small amount does not produce a sufficiently dense lateral roentgenogram. Stereoscopic roentgenograms are made of the operated area prior

to discharge from the hospital. Since September, 1943, this procedure has been employed in approximately 25 selected cases. In a few, additional roentgenograms were made several months later to see if activity had altered the appearance of the sinus.

#### OBSERVATIONS

The demonstrated disc sinus resembles an elongated slit with an irregular cross

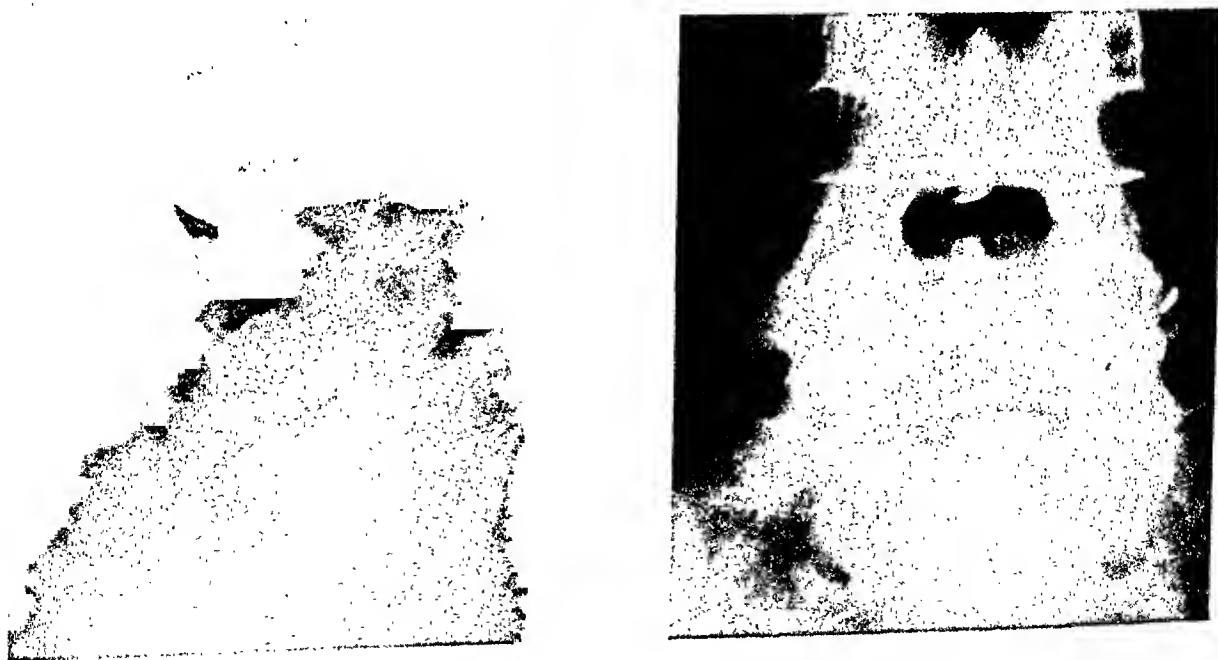


FIG. 3. Demonstration of tantalum very near the anterior annulus. Note lateral extent of the disc defect in the anteroposterior view. (The silver clips resulted from an earlier sympathectomy.)

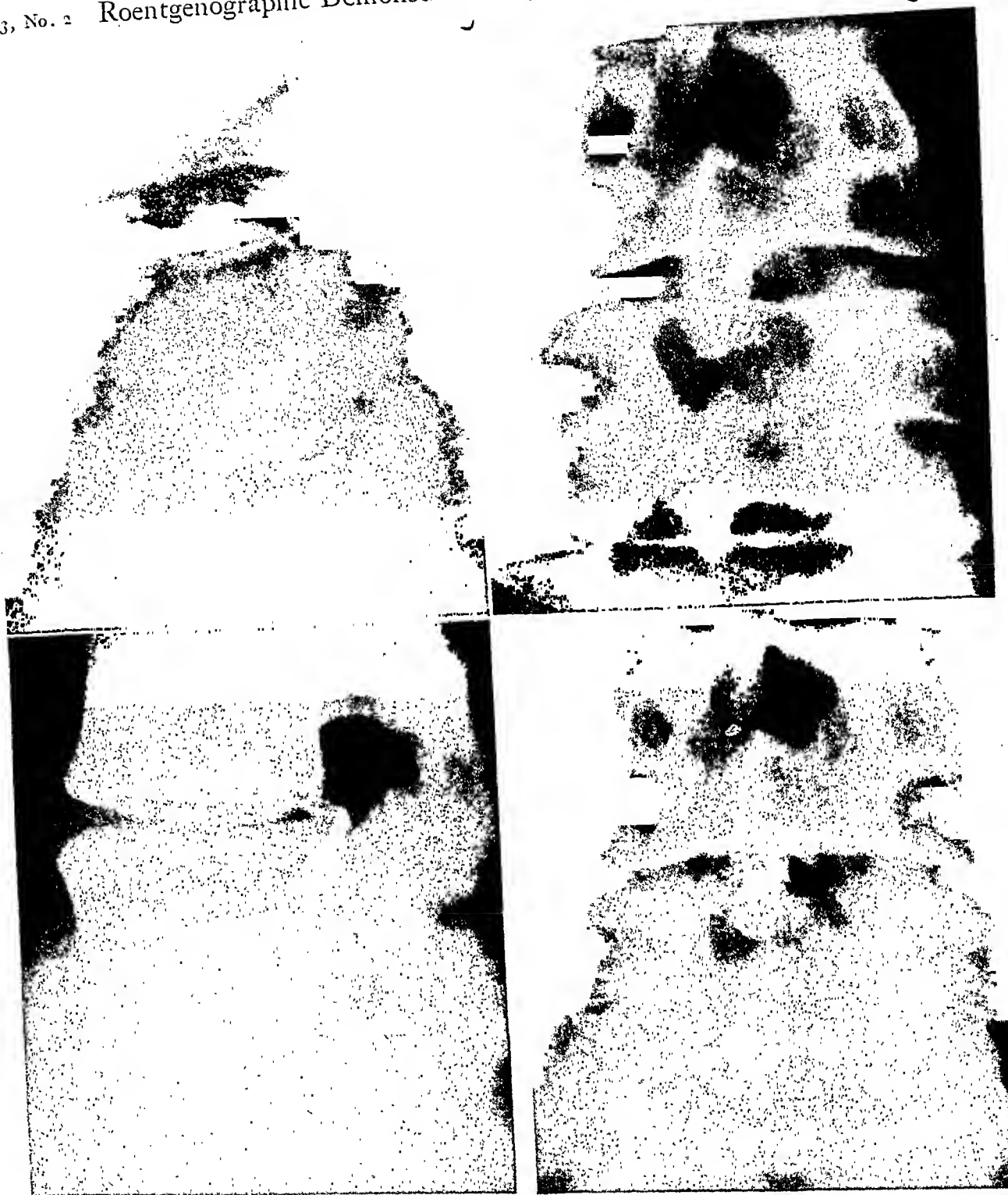


FIG. 4. *Above*—Views made after removal of disc protrusions from fourth and fifth lumbar discs.  
*Below*—Views made seven months later. Only minimal changes are apparent.

section (Fig. 2). Occasionally the shadow will suggest a round or oval cavity. In one case (Fig. 3) the opaque material extended to the anterior edge of the vertebral bodies, suggesting that the curette had approached the annulus fibrosus. This warns that curettage of the disc must be done cautiously to avoid penetration of the annulus. This has occurred in a few cases, with damage to

retroperitoneal structures, as mentioned by Love.<sup>2</sup>

Roentgenograms made after seven months of normal activity following the original (Fig. 4) show no significant alterations. We have had no opportunity to re-examine after tantalum implantation, a case with symptoms suggesting a recurrence of protrusion.



FIG. 5. Tantalum powder within a granulation removed six weeks after implantation of the powder. There is no increase in reaction in the immediate neighborhood of the powder.

#### SEQUELAE

Such implantation of tantalum powder has resulted in no untoward sequelae. The operative area has been re-examined in one case. A typical disc protrusion was exposed by interlaminar approach through the fifth lumbar interspace and 3.5 cc. of disc material was removed with the curette. Tantalum powder was introduced as described above. Six weeks later the patient displayed signs of a contralateral lesion and since she had other evidence of an unstable lumbosacral joint, re-exploration and fusion was advised. A protrusion of the same disc was removed on the opposite side. The site of the original operation then was exposed. The sinus into the disc was patent. Curettage obtained 1.5 cc. of yellowish-pink material through which could be seen conglomerate and scattered fragments of opaque black material. Histopathologic study showed (Fig. 5) mild degenerative

and regressive changes with some compact collagen and granulation tissue associated with a few bone fragments. Within some of the granulations were several small particles of black foreign material, near some of which were a few multinucleated cells suggesting foreign body giant cells. The tissue reaction was not increased around the tantalum fragments. In other areas where the powder was in contact with simple disc material, rather than in granulation tissue, practically no tissue reaction was evident.

#### SUMMARY

(1) Following removal of protrusions of lumbar intervertebral discs, the resulting sinuses have been visualized by roentgenography, with tantalum powder as an opaque medium.

(2) The sinus appears as a rather narrow defect extending toward, and in some cases to, the anterior part of the annulus fibrosus.

(3) No significant alteration in the appearance has developed after seven months of normal activity of the patient.

(4) No untoward sequelae have followed implantation of the tantalum powder.

(5) Histopathologic study, in one case, of tissue removed six weeks after implantation of the powder, showed only mild reactive changes.

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# ANOMALOUS DEVELOPMENT OF THE FIRST RIB SIMULATING ISOLATED FRACTURE

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ISOLATED fractures of the first rib are infrequently reported. The earliest description of a fracture of the first rib was presented by Jones<sup>6</sup> in 1869. In the beginning of the twentieth century 10 more cases were reported—all discovered at autopsy. Lane<sup>8</sup> found 4 cases in 200 autopsies, and reported them in 1887. More recently, isolated fractures of the first rib have been discovered by use of the roentgenogram. In 1934, Huber<sup>4</sup> reported 22 cases of isolated fractures of the first rib in an extensive search of the literature and added 4 of his own. Two years later, Breslin,<sup>2</sup> apparently unaware of Huber's paper, also compiled 22 cases from the literature, but some of these cases were not the same as those in Huber's group. Breslin added 5 cases of his own. In recent years, probably the most exhaustive investigation of the literature on this subject was undertaken by Sjögren<sup>9</sup> in 1942. After a careful perusal of the papers of Huber and Breslin, and a painstaking analysis of all available recent papers on the subject, he decided that the total number of cases of isolated first rib fractures reported in the medical literature was between 60 and 70, including 5 cases of his own. This clearly indicates the relative infrequency of these fractures.

## ANATOMY AND MECHANISM OF OCCURRENCE

Before discussing the possible mechanism of isolated fractures of the first rib a brief description of the anatomy of the first rib is in order.

The first rib is deeply situated in the neck, approximately in its center, and is very adequately protected by the clavicle anteriorly and the scapula and the muscles

of the shoulder girdle posteriorly. It is the shortest of all the ribs, and is flat and broad, with a superior and an inferior surface and an outer border. The superior surface has two shallow depressions separated by the tuberculum scaleni to which is attached the scalenus anticus muscle. The subclavian vein passes over the groove in front of the tuberculum scaleni, and the subclavian artery passes behind it. The scalenus medius muscle attaches to an area between the groove for the artery and the tuberculum scaleni. Part of the serratus magnus muscle attaches to the posterior portion of the outer border of the first rib. Thus, three muscles attach to this rib. The first rib articulates anteriorly through its costal cartilage with the sternum and posteriorly with the first thoracic vertebra.

From the above description, and after due consideration of the protective factors involved, it would seem extremely unlikely that direct trauma could affect the first rib alone. What, then, is the mechanism of isolated fracture of the first rib? Sjögren enumerates three possibilities: (1) indirect trauma—the force being conducted through the clavicle; (2) direct trauma—the force being conducted through the back, and (3) indirect trauma—the force being transmitted through the manubrium sterni. The first-named mechanism he considers by far the most common. In this, the shoulder suddenly moves downward and backward and the clavicle strikes the first rib which is fixed by the scalenus anticus muscle. He likens the clavicle to a fulcrum. But Sjögren admits that his explanation (also promulgated by Lane<sup>8</sup> and Johnston<sup>5</sup> fails to explain many published and observed

cases of isolated fractures of the first rib, particularly where there is no history of trauma to the upper chest. In recent years the scalenus anticus muscle has been im-

genographic chest examinations. This gave an incidence of 1 in 3,692. Of our 17 cases, 14 have been in Negroes and 3 in the white race. All have been males, with the age group ranging from eighteen to thirty-four. In 7 cases the right first rib was involved, and in 10 cases the change was noted in the left first rib. We have observed two distinct types of change in our 17 cases. In 7 cases there was an appearance simulating callus formation about a fracture site. In 9 cases there was a change which we have chosen to call pseudarthrosis. (It should here be noted that fractures of the first rib are said to heal

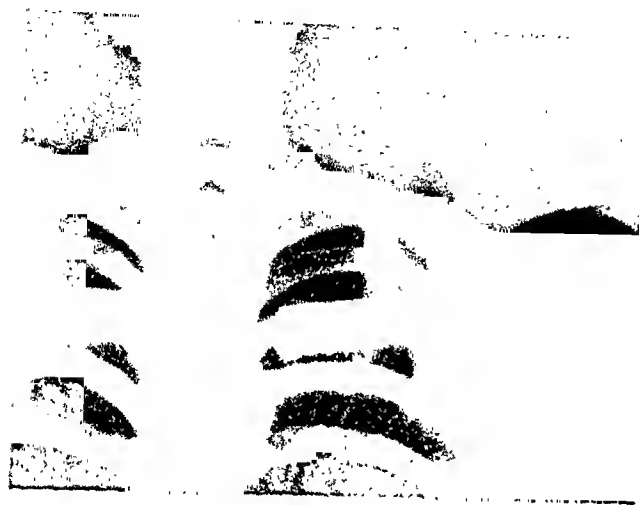


FIG. 1. Callus-like change in left first rib.



FIG. 2. Callus-like change in left first rib.

plicated in spontaneous isolated fractures of the first rib where trauma has played no rôle.<sup>7</sup> It is supposed that sudden stress with the scalenus anticus muscle contracting may cause such fractures.

We became interested in this topic in August, 1943, when we began to observe changes simulating fractures in the first rib on the chest roentgenogram. From August, 1943, until February, 1944, a period of six months, we have, in our routine work, discovered 17 cases in which the first rib has shown changes which could be interpreted as being due to fracture. During this period we have made 62,762 roent-



FIG. 3. Callus-like change in left first rib.



FIG. 4. Callus-like change in left first rib.

either by callus formation or by the appearance of pseudarthrosis as the result of

<sup>7</sup>It has been suggested that spontaneous fractures of the first rib are due to a sudden contraction of the scalenus anticus muscle. This is based on the fact that the scalenus anticus muscle is the only muscle which can contract suddenly and with sufficient force to cause a fracture of the first rib.



with the former predominating.<sup>8,9</sup> In 1 case we have felt that the changes were a combination of callus-like appearance and pseudarthrosis. In Figures 1-4 we are presenting 4 examples of callus-like change. Figures 5-8 are illustrations of pseudarthrosis-like appearance. Figure 9 is our 1 example of combined change, i.e. callus and pseudarthrosis.

All of our cases were closely questioned as to past history with particular reference to the possibility of trauma or sudden onset of pain in the area of the first rib. In 16 of the 17 cases there was absolutely no

of trauma—an automobile accident six years previously, with a diagnosis by the attending physician of rib fractures of the right upper chest (the side involved by

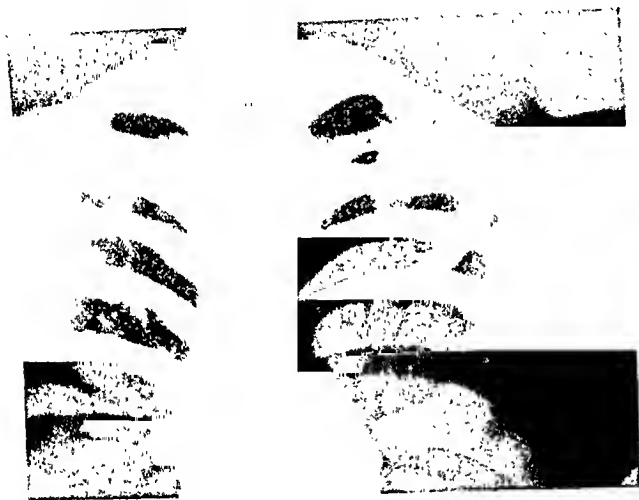


FIG. 5. Pseudarthrosis-like change in left first rib.



FIG. 7. Pseudarthrosis-like change in left first rib.



FIG. 8. Pseudarthrosis-like change in right first rib.



FIG. 6. Pseudarthrosis-like change in right first rib.

history of injury, even remotely connected with the area involved, nor was there anything to suggest a sudden onset of pain such as might occur with spontaneous fractures. In only 1 case was there a history



FIG. 9. Combined changes in right first rib.

change in the first rib). The change in this case appeared to be one of pseudarthrosis with no evidence of fracture to the other ribs. We have, to date, been unable to consult with the attending physician, or to obtain previous chest roentgenograms on this individual.

In none of our cases was there any evidence of fracture, old or recent, involving the other ribs.

#### DISCUSSION

We do not feel that any of these cases have had fractures of the first rib, either spontaneously by scalenus anticus muscle pull, or by the direct and indirect methods due to trauma, enumerated above. In the 1 case with a history of injury the pseudarthrosis-like change does not differ materially from the 8 other cases showing similar changes. Since none of the other ribs in this individual show evidence of old fracture, our opinion is that no fracture of the first rib was ever present in this individual. It is quite possible that after the automobile accident roentgenograms showed the defect in the first rib and fracture was diagnosed on this basis.

We are of the definite conviction that in all of our cases the changes, as demonstrated, are due to anomalous development of the first rib. The possibility of such development is not stressed in the American literature, and in the literature available to us it is not even mentioned. The foreign literature that we have been able to obtain is quite vague on the subject, and where anomalous development is mentioned, these anomalies occur at the costochondral junction and cannot be mistaken for fracture. In this connection it is interesting to note that the skeleton of the bird contains a joint on the first rib. We would like to point out that such anomalies may occur in the clavicle as shown recently by de Lorimier.<sup>3</sup> He calls them "mesenchymal articulations." From the roentgenographic reproduction in de Lorimier's book it is evident that the defect in each clavicle in his case closely simulates our group of

cases with pseudarthrosis-like appearance.

We are not suggesting that isolated fractures of the first rib, as heretofore reported in the literature, do not occur. On the contrary, many of the case reports that we have reviewed seem to authentically represent such fractures, with a definite history of injury to the area involved. Even here we are not convinced that all cases suffering trauma with a resultant diagnosis of first rib fracture actually represent fractures. It is readily apparent that such deformities as we have described might be called fractures, particularly in the wake of trauma. Most observers writing on the subject of isolated first rib fractures admit that, considering the anatomical make-up and protective features of the first rib, such fractures should occur only infrequently, since trauma severe enough to fracture the first rib should also fracture other parts of the thoracic cage and its surrounding bony structures. As for spontaneous isolated first rib fractures with no history of trauma, we believe that the reported cases should lend themselves to closer surveillance with the probability existing that a number represent anomalous first rib development. The explanation usually given for such spontaneous fractures is sudden contraction of the scalenus anticus muscle during great stress. We find it difficult to believe that a muscle pull could easily fracture a short, broad and relatively strong bone such as the first rib. It is even said that such spontaneous fractures may occur without symptoms. Thus, Axen in a personal communication to Sjögren<sup>9</sup> stated that he found spontaneous isolated fractures of the first rib in 4 out of 17,000 individuals presenting themselves for routine chest roentgenograms—all of them asymptomatic. Interestingly enough, this is an incidence of 1 in 4,222 cases, which is comparable to our incidence of 1 in 3,692. It is difficult for us, at best, to accept the "sclenus anticus muscle pull" theory of spontaneous fracture. It is impossible for us to accept the notion that it may be asymptomatic when it does occur in an otherwise healthy individual. We

have not seen the roentgenograms on Axen's cases but we make bold to state that they could very well represent the anomalous development that we believe we are dealing with.

The incidence of occurrence of this anomaly (1 in 3,692 cases in our series) indicates that we are dealing with a finding that will be seen relatively frequently, particularly by those dealing with large groups of cases, i.e. mass public health surveys, Armed Forces Induction Station examinations, etc. It is important that such cases be correctly identified as anomalies of the first rib and not fractures.

We are of the opinion that this subject is of some interest, both from an academic point of view and from the medicolegal aspect. Undoubtedly, litigation has or will come up in relation to isolated first rib fractures and the probability that the roentgenographic changes may be developmental instead of representing fracture should always be borne in mind.

#### SUMMARY AND CONCLUSIONS

1. A brief survey of the literature regarding isolated fractures of the first rib is presented.

2. The anatomy of the first rib is discussed and the possible mechanisms for first rib fractures are described.

3. Reproductions of roentgenograms of 9 out of a series of 17 personally observed

cases of first rib changes simulating fracture are included.

4. The hypothesis that these changes (callus-like formation and pseudarthrosis) are due to anomalous development is amplified.

5. The frequency of occurrence of these changes is emphasized and the probability that these apparent congenital changes may be mistakingly diagnosed as isolated first rib fractures—particularly of the "spontaneous" variety—is introduced.

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# THE TRITICEOUS CARTILAGES\*

## A ROENTGEN-ANATOMIC STUDY

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Medical Corps, Army of the United States

THE correlation between the shadows seen on roentgenograms of the neck and the normal anatomy has been well established. This is especially true in the case of the laryngeal cartilages, which when ossified lend themselves particularly well to roentgen visualization because of the contrast produced between them and the adjacent soft tissues and air-filled spaces.

This paper deals with the triticeous cartilages, small, round or oval bodies of

cartilage in the lateral hyothyroid ligament. These cartilages may undergo ossification and have been seen and identified on roentgenograms of the neck (Taylor,<sup>5</sup> Picchio,<sup>2</sup> Shanks, Kerley and Twining<sup>4</sup> and others). It is the purpose of this paper to illustrate unusual types of development which may occur in these cartilages.

The location and relationships of the triticeous cartilages is shown in Figure 1C. The mode of development of these carti-

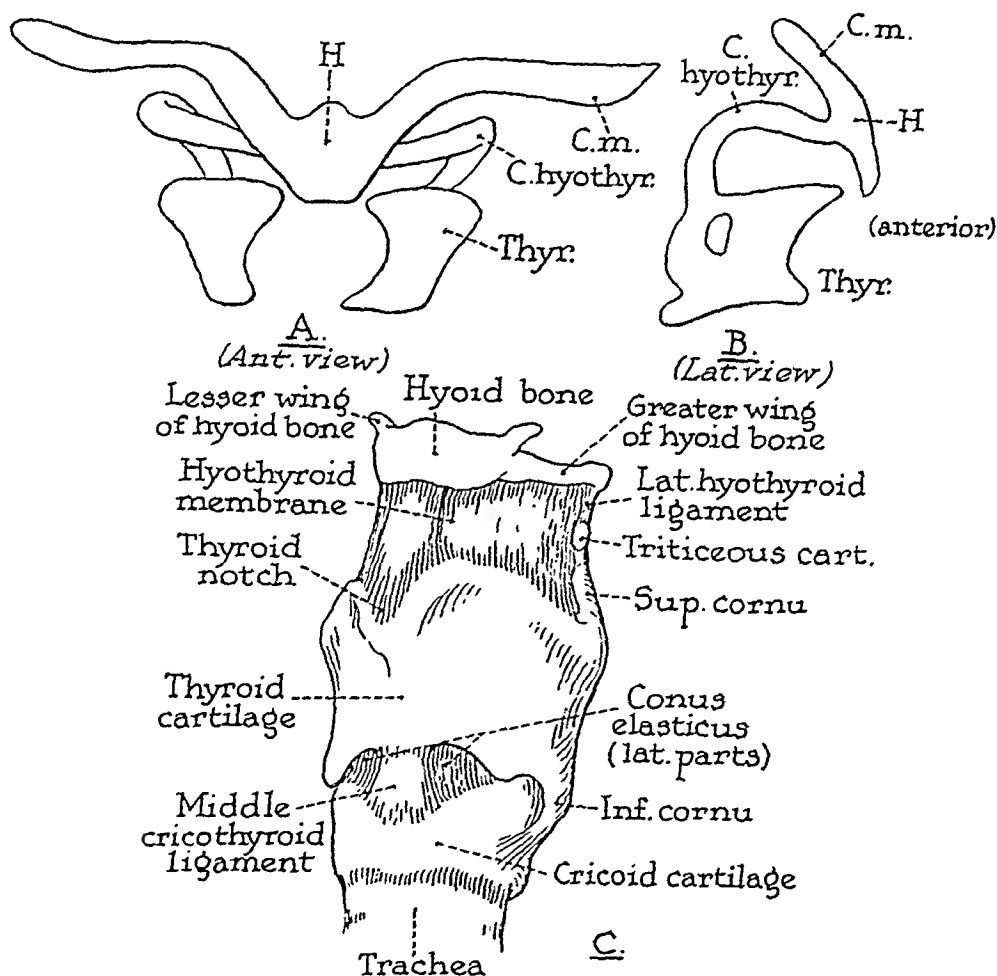


FIG. 1. A and B, the state of development of the thyroid cartilage and hyoid bone in a forty day old embryo (after Kallius from Kiebel and Mall<sup>1</sup>). H, body of hyoid bone; C. m., lesser wing of hyoid bone; Thyr., thyroid cartilage; C. hyothy., hyothyroid cartilage.

C, relation of the triticeous cartilage to the laryngeal cartilages and associated membranes and ligaments, and the hyoid bone. Oblique view.

\* All the material for this paper was obtained while the author was a resident at the University of Illinois College of Medicine, Chicago, Illinois. From the Departments of Radiology and Physiology.

lages may be briefly summarized as follows: Early in fetal development, the body of the hyoid bone and the lamina of the thyroid cartilage are joined by a curved cartilaginous bar, the hyothyroid cartilage.

horn of the thyroid cartilage. These parts remain connected by cartilage until the third month when they become discontinuous, being separated by a small island of cartilage (the triticeous cartilage) lying in

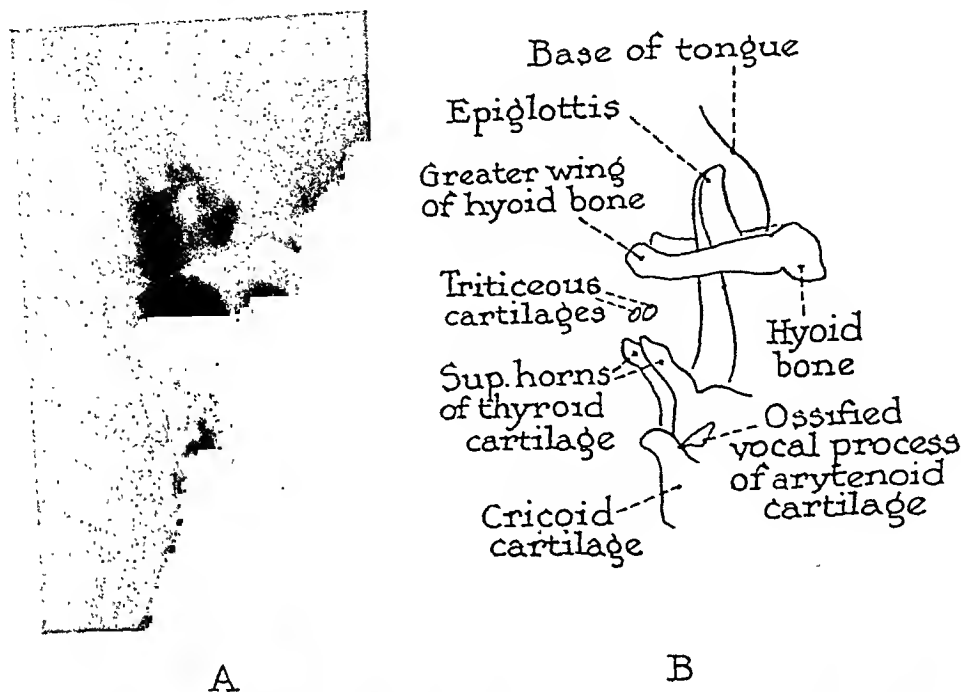


FIG. 2. *A* and *B*, roentgenogram and diagram illustrating a case of bilaterally developed symmetrical triticeous cartilages, showing a similar type of ossification.

*C* and *D*, roentgenogram of cadaver specimens to show bilaterally developed triticeous cartilages. In *C* the cartilages show a similar type of ossification. In *D* the ossification is dissimilar.

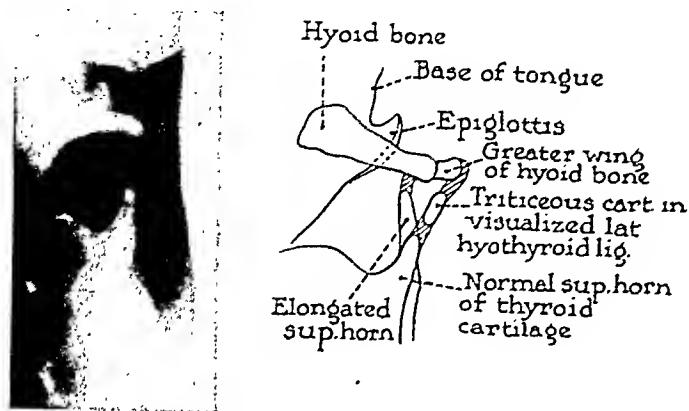
Ventrally this bar is joined to the posterior aspect of the body of the hyoid bone, and below and dorsally it becomes fused to the cartilage of the lamina of the thyroid cartilage (Fig. 1, *A* and *B*). The hyothyroid cartilage represents the skeleton of the third and fourth visceral arches. With further development the parts become molded so that the ventral portion becomes the greater wing of the hyoid bone, and the inferior dorsal portion becomes the superior

connective tissue (the hyothyroid ligament). This ligament does not reach its full stage of development until after birth, when the hyoid bone and thyroid cartilage become further separated.

The usual mode of development results in bilateral and symmetrical cartilages, one in each hyothyroid ligament. When ossified, the roentgen appearance of these is as shown in Figure 2, *A*, *B* and *C*. Occasionally the ossification may vary on the two

sides (Fig. 2 *D*). Bilaterally developed cartilages which do not ossify are not seen on the roentgenogram. A similar roentgen appearance is obtained in those instances in which the cartilages do not develop.

rior horn. The length of the elongated horn is approximately equal to the combined length of the opposite superior horn plus the developed triticeous cartilage (Fig. 3). The probable explanation of this appear-



A



B

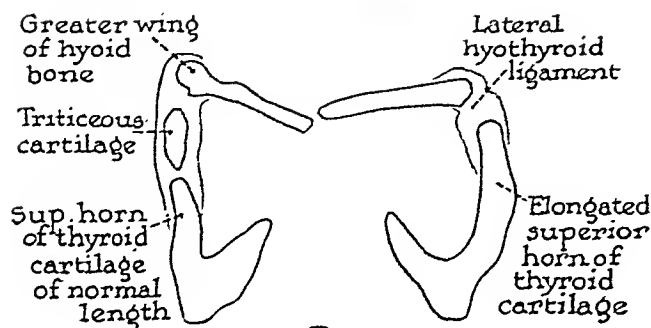


FIG. 3. *A*, lateral roentgenogram of the neck and diagram showing a unilateral ossified triticeous cartilage. The superior horn of the thyroid cartilage on the side of the absent triticeous cartilage is elongated, its length being equal to the combined length of the superior horn of the thyroid cartilage and triticeous cartilage on the other side. The roentgenogram was made during performance of the Valsalva procedure. The soft tissue shadow of the hyothyroid ligament was clearly seen and is shown by the shaded areas on the diagram accompanying the reproduction of the film.

*B*, roentgenogram and diagram of post-mortem specimen of case shown in *A*.

*C* and *D*, roentgenograms of cadaver specimens showing instances of unilateral development of the triticeous cartilage. In *C* the probable point of fusion or lack of separation of the triticeous cartilage and superior horn of the thyroid cartilage is indicated by an arrow. In *D* the superior horn of the thyroid cartilage on the side of the absent triticeous cartilage is unossified superiorly. Its tip is indicated by an arrow.

The triticeous cartilage may be present on one side only and be either cartilaginous or ossified. In cartilages which are ossified, the roentgen appearance is interesting. The superior horn of the thyroid cartilage on the side of the absent triticeous cartilage is elongated compared to the opposite supe-

ance is that in development one triticeous cartilage does not separate inferiorly but remains attached to the cartilage destined to form the superior horn of the thyroid cartilage on that side.

During the process of formation of the triticeous cartilage, irregularities in seg-



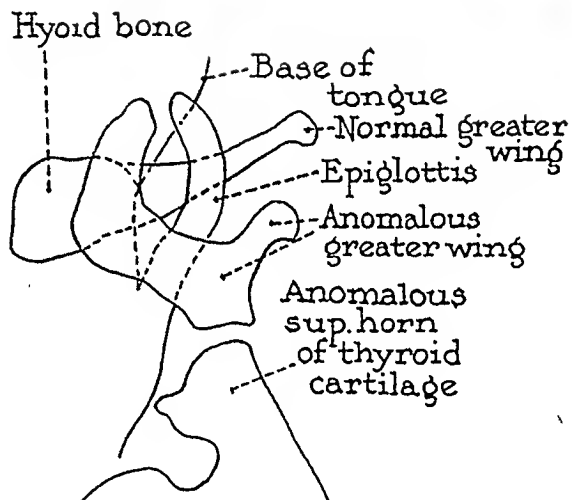
## The Triticeous Cartilages

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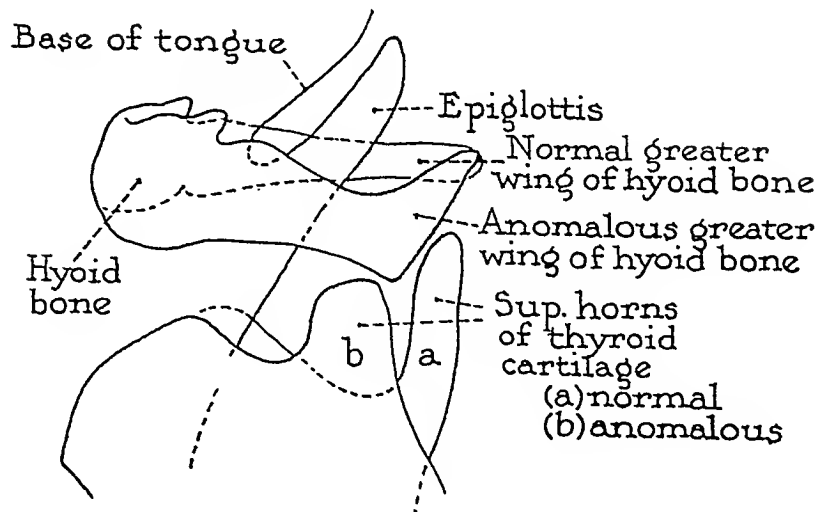
FIG. 4. Roentgenogram of a cadaver specimen showing a small accessory ossified triticeous cartilage (arrow).

mentation of the fetal hyothyroid cartilage probably explain accessory cartilages in the adult hyothyroid ligament, such as illustrated in Figure 4.

An unusual type of structure in the region being discussed is that shown in Figure 5, which probably represents an arrested stage of development. Three such cases were found in adults. Instead of the usual elongated slender appearance, the superior horn of the thyroid cartilage is blunted and widened. The greater wing of the hyoid bone is broadened and posteriorly dips down toward the altered superior horn



A



B

FIG. 5, A and B. Roentgenograms and drawings to show two instances of a type of anomaly which probably represents that stage in development in which the hyoid bone and thyroid cartilage are joined by the hyothyroid cartilage. In A the normal superior horn of the thyroid cartilage is not ossified. In B it is ossified.

destroying both tables of the skull. The patient again disappeared for some months, and during this time the process spread progressively. March 15, 1938, roentgen treatment, applied tangentially anteriorly, 2,000 r, focal skin distance 12 inches, 98 kv. (peak), 5 ma., 3 inch cone, no filter; on March 19, 1938, this treatment was repeated, this time posteriorly (4,000 r total).

On July 25, 1938, no metastases could be observed, there were no neurological signs, and the blood count revealed 3,640,000 erythrocytes, 8,500 leukocytes, 78 per cent hemoglobin. On July 30, the tumor, as well as the underlying bone (3 cm. beyond the neoplastic tissue), was removed. The dura, not adherent, appeared considerably thickened and showed an inflammatory reaction corresponding to the center of the lesion. Postoperatively there were no signs of cerebral injury or increased intracranial pressure. During the period of recovery, when a fair granulation was produced by wet azochloramide dressings 1:3,300, a dura fistula was discovered. On September 2, 1938, the thickened necrotic portion of the dura was excised revealing its under surface to be perfectly smooth and not adherent to the brain. A superficial small cortical abscess was easily evacuated, and an iodoform pack inserted.

Whereas there were no signs in the central nervous system during the first few days after removal of the abscess, there was a slight progression of the abscess cavity, and on September 12 the left upper extremity was spastic paraplegic, the left lower weak with exaggerated reflexes. Abdominal reflex absent, no sensory disturbances. The abscess cavity then grew smaller, and on September 26 there was no drainage. However, a cerebral fungus developed with considerable sloughing of the protruding portion. The neurological findings remained unchanged.

After a Thiersch graft on September 30 the cerebral hernia receded, and had disappeared by December 1, 1938. The motor power of the lower extremity returned, and the patient was able to walk. The biopsy of the dura showed an inflammatory process as well as replacement of the dura tissue by neoplastic cells; the diagnosis was epithelioma.

The patient left the hospital but returned in January, 1939. Biopsy on January 10 revealed a diffuse recurrence of the neoplasm. On January 28, irradiation to the exposed part of the

brain and dura, 85 kv. (peak), 5 ma., no filter, focal skin distance 20 inches, 3 inch cone, 650 r; repeated on February 3 (1,300 r total). Very marked reaction followed: cerebral hernia, 10-12 cm. diameter, projecting about 5-6 cm. above the level of the scalp.

On April 14, 1939, the patient was re-admitted to the hospital with severe headache, ulcerations along the anterior border of the original line of excision, left hemiplegia with exaggerated tendon reflex, and slight diminution of pain sensation. The cerebral hernia receded slowly in the next month when considerable sloughing, necrotic cortical tissue was cut off. On July 5, radium plaques were applied, five tubes, each containing 10 mg. of radium (1,400 mg-hr. to the anteromedial border); on July 12, 1,862 mg-hr. to the anterior border. No satisfactory effect.

While the process then receded in the center, there was an extension along the margins. Therefore another operation was performed. In spite of severe hemorrhages during the operation the patient recovered, and after a few weeks healthy granulations appeared. But by the middle of September the wound ceased to show further signs of healing, and the entire operative site presented irregular, elevated areas of pale granular tissue rising above the level of the underlying firmer granulation tissue. On September 29, biopsies were taken from five widely scattered areas and all of these showed residual islands of neoplastic cells with a tendency to formation of epithelial pearls in some areas. From this point on the patient experienced severe headache requiring repeated lumbar punctures and heavy sedation. She remained perfectly conscious and oriented until a few days before her death when she showed some evidence of confusion and disorientation. No further neurological signs developed during this time, however. The patient began to run an irregular temperature on December 17. On December 26 she lapsed into a coma and died on December 27, 1939.

*Summary.* Roentgen resistant squamous cell carcinoma of the skull with destruction of the bones and infiltration of the dura which was partly removed. Purulent infection of the wound with abscess formation occurred, followed by a left hemiplegia accompanied by protrusion of the brain and persisting until death.

*Treatment.* Roentgen therapy: December, 1936, 1,500 r; March, 1937, 2,160 r; October,

1937, 1,080 r; March, 1938, twice 2,000 r (open skull); January 28 and February 3, 1939, 650 r each. Finally radium, 1,400 mg-hr. antero-medial border (July 5, 1939) and 1,862 mg-hr. (July 12, 1939).

*Postmortem Examination. Histopathological findings:* The brain is partly covered with a thick connective tissue membrane replacing the respective part of the dura mater. This membrane consists of a matrix of cell-poor reticulin

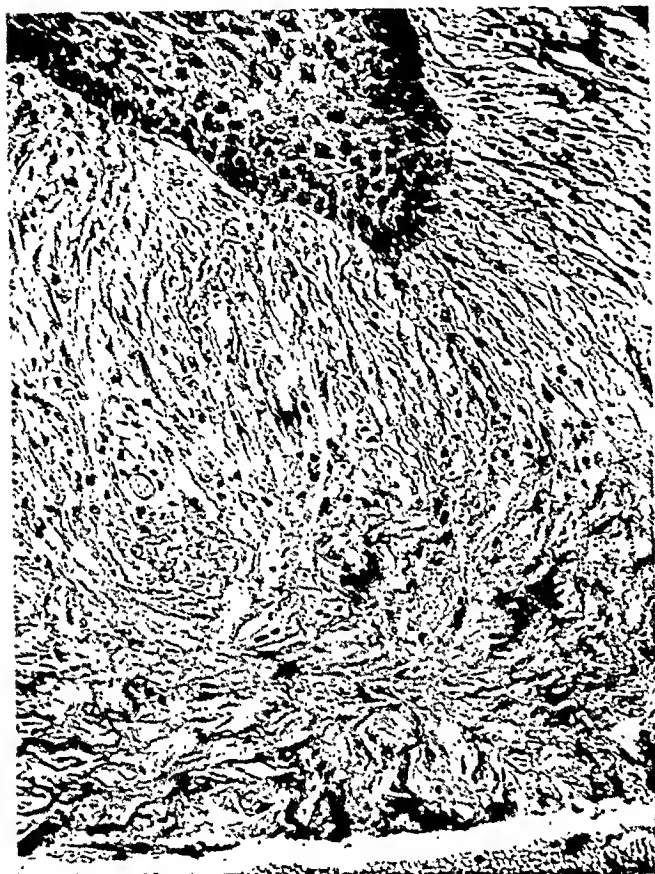


FIG. 1. Cicatricial dura mater.

from which many nucleated fibrils run toward the nodes and cones of the cancer, surrounding it with a chain of cells and a fine membrane (Fig. 1). Near this cicatrix the dura mater shows an intrusion of cancer cells via perivascular spaces (Fig. 2), forming small cell chains and bands throughout the dura. The connective tissue of the dura is spongy, rather loose, and edematous. Occasionally one finds some cancer pearls and near them single cancer cells (Fig. 3) with a division of the nuclei indicating the progression of the process. Unfortunately a suppurative process has changed the picture so that one encounters in addition to the cancer, a purulent infiltration of the dura (Fig. 3).

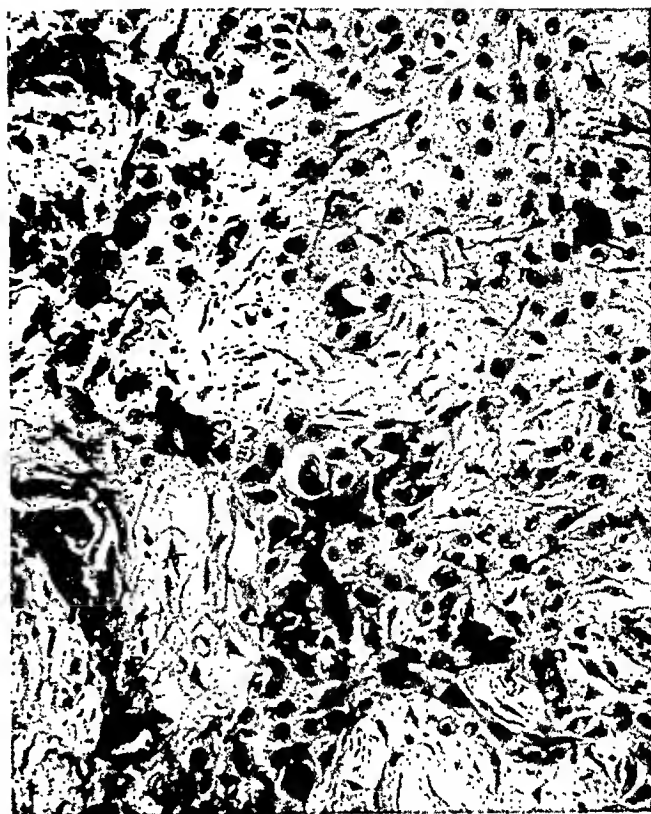


FIG. 2. Dura mater. Cancer cells along the blood vessels.

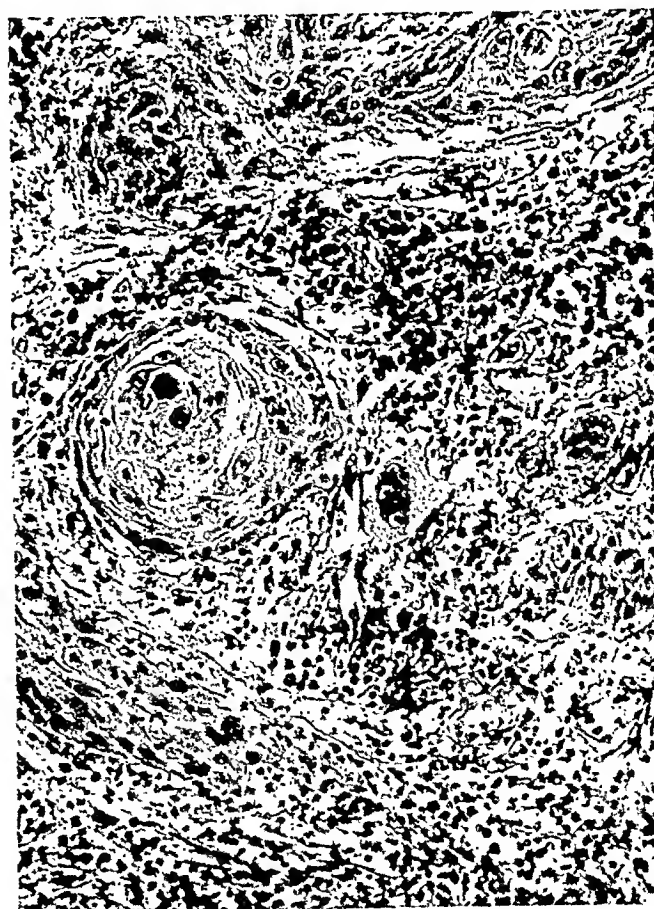


FIG. 3. Cancer node and inflammation within the dura mater.

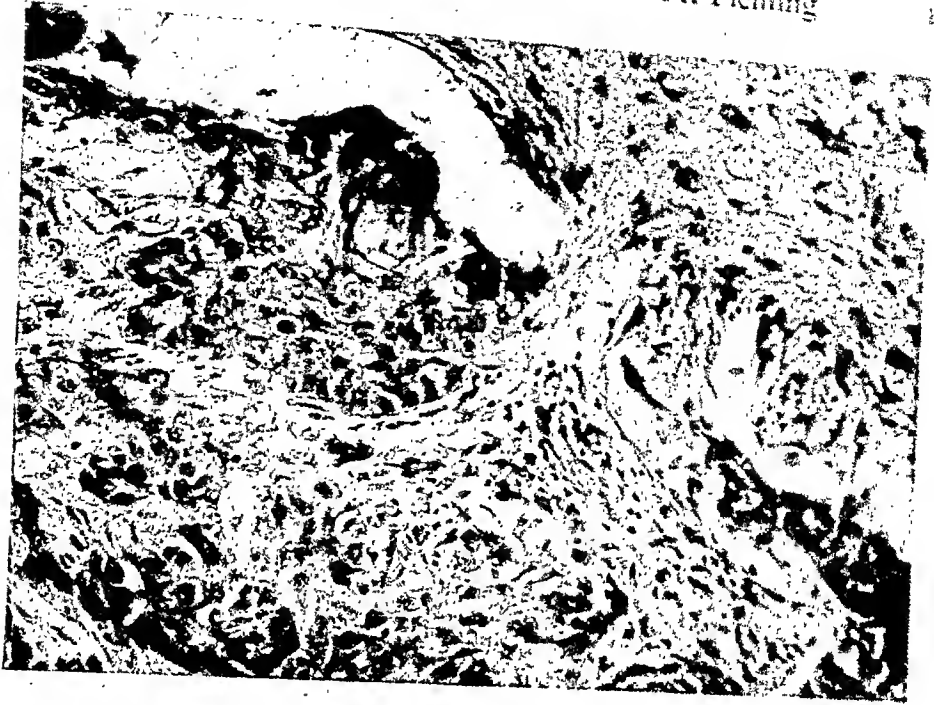


FIG. 4. Pia mater. Cortical glia intruding into the pia.



FIG. 5. Inflammation of pia mater and cerebral cortex.

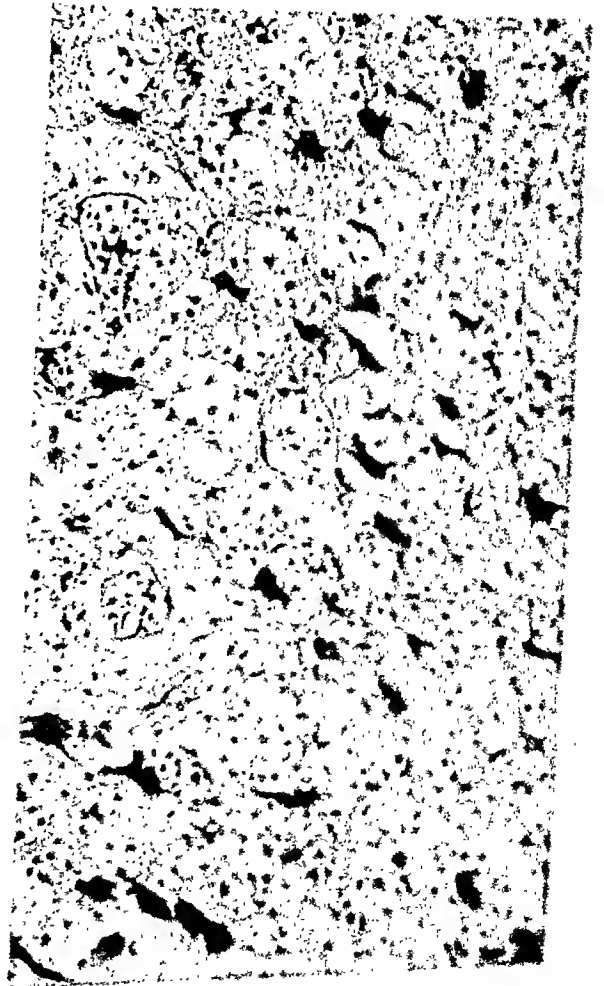


FIG. 6. Malpighian and glomerular structures.



The pia mater is also filled with cancer cones and nodes which, however, do not spread into the brain. There is a space between pia and brain which contains glia fibrils entering into the pia (Fig. 4).

In the brain, three different pictures can be observed: (1) In one part there is suppurative encephalitis (Fig. 5). (2) Another part shows multiple malacias. One sees here compound granular cells around small blood vessels the walls of which are homogeneic. Groups of these cells are surrounded by giant astrocytes (Fig. 6) which adjust their form to the circularly arranged compound granular cells. There is some beginning fibrillogenesis (Fig. 7). Another group of these giant glia cells is disintegrated, with vacuoles and clasmato-dendrosis (ameboidism) (Fig. 8). (3) Along the pial blood vessels tumor cells infiltrate into the brain and isolate parts of the cortex that are completely necrotic and present only a glia fibril network with some shrunken glia cells (Fig. 9).

The transition from these affected portions to the normal areas is represented by a stripe of edematous tissue with wide gaps. This tissue shows only little reaction in general, which is easily explained by the obstruction of the perivascular lymph spaces by compound granular or cancer cells.

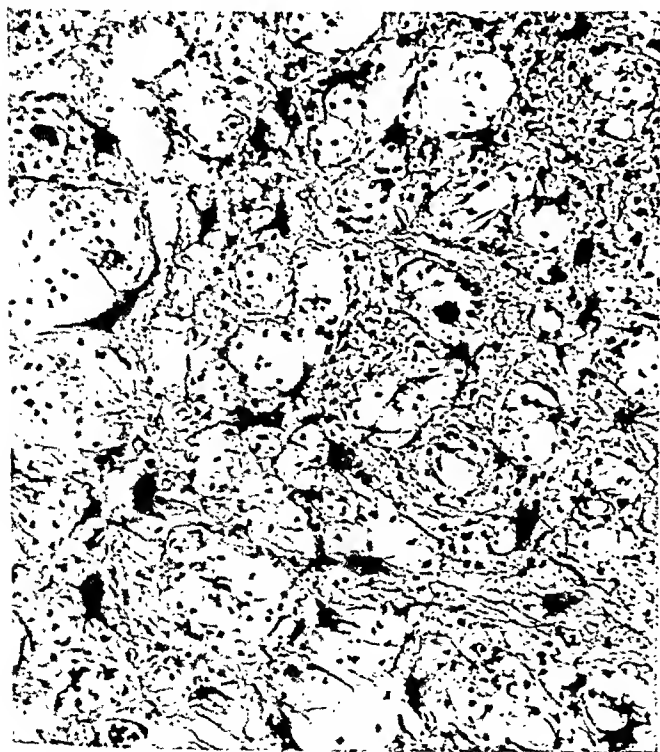


FIG. 7. Fibrillogenesis of the giant glia cells.

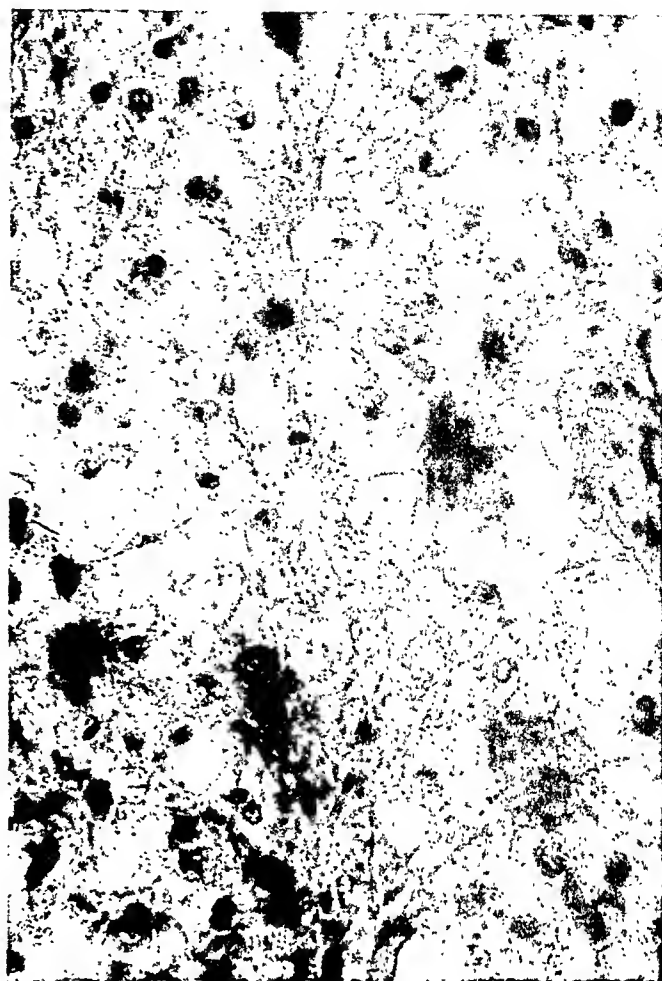


FIG. 8. Ameboidism of the glia cells.

The destruction of the ganglion cells near areas of necrosis or malacia is very advanced. The cells are shrunken, dark without a vestige of a nucleus, and present no dendrites. These changes occur, however, only rather close to the foci. Next there is seen a thin stripe of swollen ganglion cells, and finally normal cells. The damage of the most severely affected portions of the cortex extends into the white matter.

The changes in the blood vessels vary according to the size of the vessels. The capillaries present swollen intima cells, their walls are occasionally pale, their lumina are obstructed. In the larger vessels the intima is not swollen, the walls are rather homogeneous, the nuclei of the muscularis and the adventitia are not recognizable, and the homogenization of the media resembles that in arteriosclerosis. Occasionally a small artery is stained so dark in hemalum and eosin preparations that calcification is suggested. The adventitia is pale and consists of a loose network of fibrils without nuclei.

Macroscopically the brain gave the impres-

sion of hemiatrophy of the affected hemisphere. Accurate examination, however, revealed that the shape of this hemisphere was changed because the cicatrix below the wound had shrunk and had shifted the entire ventral part of the hemisphere ventrally and laterally.

The examination of the contralateral side showed relatively normal conditions. Unfortunately there was a generalized shrinkage; some of the pyramidal cells were pyknotic, homogeneous and black stained, but their nuclei were normal. Most of the cells presented a

hemorrhages, malacias, and progressive as well as regressive changes of the glia accompanied by progressively deteriorating clinical signs. Whereas Mogilnitzky and Podljaschuk particularly stressed the changed permeability of the blood vessel walls, Scholz claimed that the damage of the blood vessel walls leads to roentgen changes of the brain resembling those described by Windholz. Scholz in addition assumed a functional lesion of the vaso-

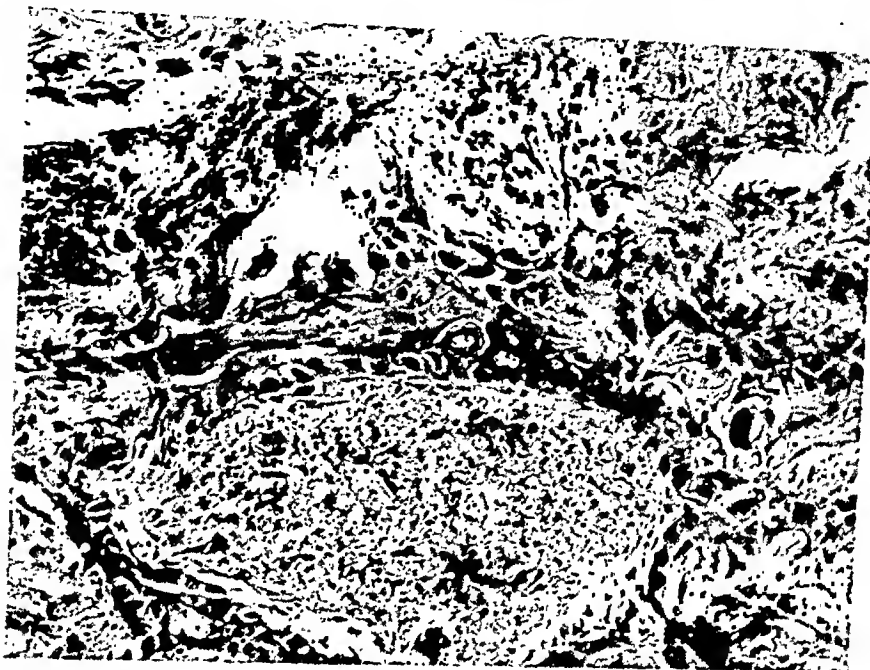


FIG. 9. Pia mater and cortex. Infiltration of cancer cells.

normal staining in Nissl preparations. Hemalum and eosin stained sections failed to show any abnormality.

The question arises as to which of the changes are caused by cancer and inflammation, and which by the irradiation. That is difficult to decide in the present case because the changes caused by cancer, and those caused by the irradiation are partly the same, namely obstruction of blood vessels with its sequelae. In some regions, however, in the present case the pia mater is not affected by cancer, and yet these regions present changes as described in the experiments of Davidoff, Dyke, Elsberg and Tarlov. Their findings are in agreement with those of W. Scholz who, in animals surviving for a longer time, found

motor nerves explaining the progressive clinical signs.

In the present case the changes are not in complete agreement with those described by Scholz,<sup>12</sup> and by Lyman, Kupalov and Scholz.<sup>5</sup> The adventitia appears rather pale in hemalum and eosin preparations without the hyalin transformation seen in Scholz's<sup>12</sup> experiments, and the fibrils are distended by deposition of compound granular cells. Some homogenization of the media is seen resembling an incipient calcification.

The most striking fact in the present case was the relatively late onset of the clinical signs. Six months after the irradiation of the open brain, hemiplegia occurred which corresponds with Scholz's experimental



statements. It is evident that neither the abscess nor cancer was the cause of this hemiplegia since both were removed two months before the onset of paresis when examination revealed that the dura was not adherent and that there were no signs of cerebral injury. In addition, the freshness of the malacias suggests with some reservation that the irradiation caused the damage as well as the clinical signs.

All the writers stress the reaction of the glia, particularly the progressive and regressive changes occurring close to each other. The same is seen in irradiation gliomas as described by Marburg,<sup>6</sup> Roussy, Laborde and Lévy,<sup>11</sup> Tarlov,<sup>13</sup> Dyke and Davidoff,<sup>2</sup> and many others. As mentioned, this reaction surpasses the usual glia reaction seen in secondary degeneration, and on the other hand, neuronophagia is absent in spite of a degeneration, though not very extensive, of the ganglion cells. That means that the trophic and defensive reaction of the glia is well preserved, or may be improved by irradiation. The ameboidism observed at the same time is no proof to the contrary since according to Pollak<sup>10</sup> progressively changed glia cells when assuming trophic functions are transformed into compound granular cells (dysplasia).

As for the ganglion cells, it was not possible in the present case to find vacuolization as described by Davidoff, Dyke, Elsberg and Tarlov.<sup>1</sup> Nor were there such pale, atrophic ganglion cells as described by Spielmeyer as sequelae of anemia. Near the foci there were shrunken, malformed, homogeneous cells, stained dark with Nissl methylene blue (coagulation necrosis according to Marburg), without the vestige of a nucleus. In their neighborhood some swollen ganglion cells resembled those in acute degeneration. A transition from one state to the other could not be demonstrated. In any case, the changes were seen only in close proximity to the malacic or necrotic foci which did not extend deeper than into the white matter of the cortex convolution; that means that the effect of

the irradiation ended 0.5 cm. from the surface. The intactness of the other parts of the cortex as far as they were examined is surprising.

#### SUMMARY AND CONCLUSIONS

In a case with a roentgen resistant squamous cell carcinoma of the skull, the bone was perforated by the cancer. The brain, already previously irradiated, now lying free by the perforation, was treated with roentgen radiation (4,000 and later 1,300 r) and finally with radium.

In spite of the infiltration of the cancer into the brain, and a concomitant abscess, the changes which occurred may be attributed in part to the irradiation because of their resemblance to experimental findings.

The primary changes are those of the blood vessels. The obstruction of the capillaries, the disintegration, and the increased permeability of the blood vessel walls may also be due to a functional impairment of the vasomotor nerves.

A vivid (defensive and atrophic) glia reaction as well as a particular cell degeneration in the neighborhood of the malacic foci are to be stressed. The relative intactness of the contralateral side is striking.

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# THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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## FACTITIAL REACTIONS IN CONNECTION WITH IRRADIATION OF THE PELVIS

THE successful irradiation of most deep-seated malignant neoplasms necessitates the administration of such large doses that a certain effect on the surrounding normal structures often cannot be avoided. The clinical course and pathological significance of this effect have formed the topics of numerous studies, and there is now a voluminous literature published on the subject.

Of late, however, in not a few of the articles a rather disproportionate emphasis is laid on the injurious nature of the irradiation effect. This applies especially in regard to the pelvis, where such highly sensitive organs as the lower portions of the intestinal and urinary tracts are included within the irradiated volumes. A brief review of the entire subject in the light of the newer developments may therefore not appear out of place.

In 1930, Buie and Malmgren<sup>1</sup> used the term "factitial proctitis" in order to designate pathologic phenomena observed within the rectum following radium or a combination of radium and roentgen therapy given for extrarectal lesions. The generalization of this term to include all reactions and sequelae which are noted in organs or structures other than those for which the irradiation was intended may serve a good purpose. Thus one could speak of factitial colitis, cystitis, late ulceration, and so forth, giving expression to the fact that the process was unintentionally produced but that it could not be avoided. The adoption

of such nomenclature might, with time, perhaps lead to the elimination of the injudiciously used term of "burn" which creates considerable confusion and distrust. Obviously, cases are encountered in which the irradiation damage is the result of a gross overdosage or a faulty technique but our interest here concerns those instances in which the reactions and late sequelae follow more or less standard techniques as employed in current radiologic practice.

*Factitial Reactions of the Lower Intestinal Tract.* In irradiating the pelvis, a reaction may develop in that portion of the intestinal tract which normally is situated in the pelvis or which, under certain abnormal conditions, may drop or be pulled into the pelvis, as for example, by adhesions. The parts involved are usually the rectum, the rectosigmoidal junction, the loops of the sigmoid and occasionally the loops of the small intestine. In a decreasing order of frequency and severity the reactions are observed in the treatment of cancer of the vaginal canal, prostate, cervix uteri, corpus uteri, bladder, ovaries and certain less common lesions. At times they are the result of roentgen therapy alone, especially when the fractionated protracted method is used over a long period, but more often they are due to the effect of radium, or a combination of roentgen therapy and radium.

There were a number of articles published during the last few years dealing with all effects of the factitial reactions of the lower intestinal tract. Corscaden,<sup>2</sup> Kasabach and Lenz,<sup>3</sup> Todd,<sup>4</sup> Aldridge,<sup>5</sup>

<sup>1</sup> Buie, L. A., and Malmgren, G. E. Factitial proctitis; a justifiable lesion observed in patients following irradiation. *Internat. Clin.*, 1930, 3, 68-77.

<sup>2</sup> Corscaden, J. A., Kasabach, H. H., and Lenz, M. *Internat. Clin.*, 1930, 3, 78-80.

Randall and Buie,<sup>5</sup> and others, have furnished us with a very vivid description of the clinical and roentgen appearance of such conditions. It is clear from these descriptions that we are dealing with an acute and chronic phase of the process. The acute phase starts toward the end or immediately after the completion of the irradiation series and is of a transitory nature. Clinically, it manifests itself by tenesmus, frequency of defecation and occasional rectal bleeding. Proctoscopic or sigmoidoscopic examination reveals diffuse hyperemia of the rectal mucosa and the presence of fibrinous flakes, usually more pronounced in the areas near where the radium was applied. This mucositis often assumes a thick edematous or granular appearance and is followed by a mucosal desquamation similar to that observed in mucosal membranes of other locations or in the teguments of the skin. A roentgen study by means of a barium enema shows practically no findings of significance during this phase. The acute mucositis in the great majority of cases clears up completely without further after effect. In some instances, however, it gives place to an atrophy and telangiectasis of the mucosa which then are permanent manifestations forming the source of recurrent bleedings or local bowel symptoms of varying degree.

The chronic phase is characterized by more deep-seated involvement of the structures. The various authors place the onset at an average of six to ten months after treatment, with a minimum interval of one week and a maximum interval of ten years or longer. The first warning that anything is wrong occurs when the patient suddenly develops a gross rectal hemorrhage. This is

followed by discomfort on defecation, later by pain and eventual stenosis. All investigators stress the fact that at this time the proctosigmoidoscopic as well as the roentgen appearance is that of a pseudocarcinoma and that biopsy is often necessary to make a differential diagnosis. On inspection there is a deep grayish-white ulcer in the center of a proliferating granulation tissue and not infrequently there is a massive pelvic induration leading to a frozen pelvis. It is probable, however, that in this latter instance a residual infection from the original sphacelated malignant neoplasm accounts to no small degree for the deep induration. On roentgen study filling defects, tubular constrictions and rarely complete stenosis form the chief manifestations. In occasional cases communicating fistulae may be encountered.

A review of the literature reveals considerable discrepancy concerning the incidence of the acute phase of the factitial lower bowel reaction but there is good agreement concerning the late sequelae. This is understandable. In the great majority of the acute reactions no systematic observations are made and, since they are of a transitory nature, most of them pass unnoticed. In some institutions there is a tendency to consider the presence of an acute mucositis of the lower bowel and bladder as an indicator of proper dosage for the irradiation of certain well chosen pelvic lesions. Under such circumstances the incidence may be almost 100 per cent. For the late sequelae, Buie and Malmgren,<sup>1</sup> noted a percentage incidence of 3.13 in 2,073 cases treated at The Mayo Clinic from 1921 to 1930, occurring mostly following roentgen and radium therapy of carcinoma of the cervix and fundus uteri, carcinoma of the ovary and other pelvic lesions. Later, when the dose was considerably increased, Corscaden, Kasabach and Lenz<sup>2</sup> reported an incidence of 8.7 per cent in 442 cases of uterine carcinoma. Todd,<sup>3</sup> in analyzing the cases irradiated at the Christie Hospital and Holt Radium Institute of Manchester found a percentage incidence

injuries after radium and roentgen treatment of carcinoma of the cervix. *Am. J. Roentgenol. & Rad. Therapy*, 1938, 39, 871-887.

<sup>2</sup> Todd, T. F. Rectal ulceration following irradiation treatment of carcinoma of the cervix uteri; pseudo-carcinoma of the rectum. *Surg., Gynec. & Obst.*, 1938, 67, 617-631.

<sup>3</sup> Aldridge, A. H. Intestinal injuries resulting from irradiation treatment of uterine carcinoma. *Am. J. Obst. & Gynec.*, 1942, 44, 833-857.

<sup>5</sup> Randall, L. M., and Buie, L. A. Factitial proctitis. *Am. J. Obst. & Gynec.*, 1943, 45, 505-512.

of 4.5 of all treated cases. He noted a similar incidence at the Marie Curie Hospital of London and from a personal visit to Radiumhemmet of Stockholm gathered the impression that this was also approximately the incidence in Heyman's cases. Chydenius,<sup>6</sup> in using the "Stockholm method" of irradiation, found a percentage incidence of 4.8 in 321 cases of carcinoma of the cervix uteri, occurring mostly in the very advanced cases. Aldridge<sup>4</sup> in 1942 published a series of 189 cases of uterine carcinoma treated by irradiation, in 16.9 per cent of which intestinal injuries occurred, but this high incidence, as the author states, is due to the fact that every case of proved injury has been reported even if the findings were extremely mild, giving rise to only transient symptoms. In a more recent publication, McIntosh and Hutton,<sup>7</sup> dealing with the same material from a different point of view and adding some additional cases, likewise express the opinion that a number of these cases would not have been discovered had the authors not been particularly engaged in looking for them.

The possibility of factitial intestinal injuries being generally admitted, attempts were made to devise procedures which would prevent, or at least minimize, their occurrence. Aldridge<sup>4</sup> compiled a rather long list of suggestions, some dealing with the technical application of the radium so that it would not get dislodged or lie too close to sensitive mucosal membranes, others advocating various studies, including even a pre-irradiation exploratory laparotomy to determine whether loops of intestine are adherent in portions that might subject them to too much irradiation. The most important suggestion, however, refers to a change in the actual technique of irradiation. It was thought that by decreasing the amount of radium and roentgen radiation that is given at one time and by

spacing it over a longer period the difficulty could be overcome, at least to a certain extent. Such a procedure has been adopted in a number of the leading institutions during the past eight or ten years. Yet, Cosbie,<sup>8</sup> in analyzing the cases of bowel injury at the Ontario Institute of Radiotherapy of Toronto, where the change to the newer technique was made in 1937, states that as a result of the fractionation of the radium and the introduction of higher voltage roentgen rays, proctitis was less common, but late ulcerations became more frequent. A very valuable article dealing with a multiplicity of factors aiming to eliminate irradiation injuries in the treatment of cancer of the cervix was published not very long ago by Charles L. Martin.<sup>9</sup>

As far as the treatment of the late sequelae of the bowel is concerned, there is now a unanimity of opinion that this must be along conservative lines. Actual or chemical cauterants should never be used and the surgical procedures should be reserved for carefully chosen cases. This non-operative treatment was recently stressed by McIntosh and Hutton<sup>7</sup> who found that even severe and extensive bowel injuries often heal with very little functional impairment, though marked anatomic defects may be present. There are a few cases of fatal outcome recorded in the literature.<sup>8</sup>

*Factitial Cystitis.* What has been said about the factitial irradiation effect on the lower intestinal tract also applies to the bladder. The evolution and clinical course of the mucositis follows the same pattern and the mechanism of the late sequelae is based on the same principles.

There are a few distinguishing features. One of these is the fact that the bladder mucosa is slightly less radiosensitive than the bowel mucosa. As a result, the symptoms in the acute phase are somewhat less

<sup>6</sup> Chydenius, J. J. Strahlenschäden des Darmes und der Harnblase bei der Radiumbehandlung des Carcinoma colli uteri. *Acta radiol.*, 1942, 23, 1-7.

<sup>7</sup> McIntosh, Harriet C., and Hutton, J. E. Clinical and roentgen aspects of irradiation stricture of the rectum and sigmoid. *Am. J. Roentgenol. & Rad. Therapy*, 1944, 52, 647-662.

<sup>8</sup> Cosbie, W. G. Complications of irradiation treatment of carcinoma of the cervix. *Am. J. Obst. & Gynec.*, 1941, 42, 1003-1008.

<sup>9</sup> Martin, C. L. Elimination of irradiation injuries in the treatment of cancer of the cervix. *Am. J. Roentgenol. & Rad. Therapy*, 1943, 49, 494-503.



pronounced and the appearance of the chronic ulcers occurs at a later date, the average being about two years and six months after irradiation. For the same reason, the incidence of the late sequelae is smaller. Dean and Slaughter,<sup>10</sup> for example, in analyzing a group of 3,041 patients treated with irradiation for uterine and ovarian diseases at the Memorial Hospital of New York, found that only 2.48 per cent of these patients sought relief later because of injured bladders. The incidence varied with the disease irradiated. It was least for fibromyoma (0.38 per cent) and greatest for postoperative recurrent carcinoma of the cervix (7.51 per cent).

Another point is that healing of a factitial bladder ulceration is dependent on the size and location of the ulceration. In this respect the situation is similar to that observed in primary ulceration of the bladder when interstitial radium is applied alone or in conjunction with roentgen therapy for the treatment of a neoplasm of the bladder proper. Herger and Sauer,<sup>11</sup> in analyzing a group of 279 patients with tumors of the bladder treated with radon implants, found that in no less than 80.7 per cent of the cases extensive ulceration resulted. In those cases in which the ulcerations eventually healed, it took an average of 10.6 months for the healing process to be completed. In a significant number of cases the ulceration never healed, especially if they were larger than 5 cm. in diameter. As a rule, the duration of the healing was in direct proportion to the size of the area involved and the amount of interstitial radium used. Ulcerations of the loose walls of the bladder healed faster than those in the fixed parts of the bladder. The development of incrustations prolonged the duration of the healing.

<sup>10</sup> Dean, A. L., and Slaughter, D. P. Bladder injury subsequent to irradiation of the uterus. *J. Urol.*, 1941, 46, 917-924.

<sup>11</sup> Herger, C. C., and Sauer, H. R. Occurrence and clinical course of radium reactions following use of radon implants in treatment of carcinoma of bladder. *J. Urol.*, 1942, 47, 141-147.

Finally, a third point has to do with the peculiar anatomy of the bladder. Hueper and his coworkers<sup>12</sup> recently produced experimental radiocystitis in a series of 22 male mongrel dogs and observed the changes up to a period of eleven months. They noted all the pathologic lesions equivalent to those found in radiocystitis of the human. But, surprisingly, a secondary infection of the bladder with fecal flora also developed. The authors attributed this to the irradiation injury of the rectovesical septum and the vesical mucosa. This observation is important since it may help to explain why the administration of sulfa drugs in the acute phase of factitial or actual radiocystitis in the human produces such prompt relief of symptoms. Even in cases of late sequelae rapid improvement is obtained as soon as the infection is eliminated.

All in all, it appears that with the heavy irradiation, amounting to several erythema doses at many critical points, as is practiced nowadays in the treatment of malignant neoplasms situated within the pelvis, factitial reactions cannot be avoided. Acute mucositis of the lower bowel and bladder represents a common manifestation and its degree often serves as a control of the correctness of the dosage applied. Late sequelae of the lower intestinal tract are encountered in about 5 per cent and of the bladder in about 3.5 per cent of all treated cases. As Randall and Buie<sup>5</sup> say, they represent ordinary risks that the patient assumes when such treatment is undertaken. With very few exceptions, their ultimate prognosis is good and in comparison with the original lesion for which the radiation therapy was given, the inconveniences they cause to the patient are disproportionately small.

T. LEUCUTIA

<sup>12</sup> Hueper, W. C., Fisher, C. Virginia, de Carvajal-Forero, J., and Thompson, M. R. Pathology of experimental roentgen-cystitis in dogs. *J. Urol.*, 1942, 47, 156-167.



ALEXANDER HOWARD PIRIE,  
M.D., F.R.S.M. (LONDON), F.F.R.

1875-1944

**D**R. ALEXANDER HOWARD PIRIE, Past President and Life Member of the American Roentgen Ray Society, long-time (1911-1938) Radiologist-in-Chief, Royal Victoria Hospital, Montreal, and Lecturer in Radiology, Faculty of Medi-

cine, McGill University, died in the Ross Pavilion of the Royal Victoria Hospital on November 23, 1944, after a sudden and short illness near the close of his sixty-ninth year.

Son of a physician of Dundee, Scotland,

young "Sandy" Pirie was completing his education at St. Andrew's and Edinburgh University when Roentgen astounded the scientific world with the announcement of his discovery. Together with his brother, who was to become one of the early martyrs to overexposure, Dr. Pirie soon became absorbed in the medical application of the x-rays. Following a period of study at the Sorbonne, and a visit to Canada in 1897, he became established in Harley Street, London, subsequently becoming associated with another pioneer in British Radiology, the late noted Dr. Robert Knox.

In 1911, relinquishing appointments at St. Bartholomew's, the Prince of Wales and Mount Vernon Hospitals, Dr. Pirie accepted the invitation of the Governors of the Royal Victoria Hospital, Montreal, to become its Radiologist-in-Chief, succeeding the late Professor Girdwood. His versatile ingenuity there enjoyed full play in the adoption and adaptation of each new development in equipment for diagnosis and treatment. The Department of Radiology of this eminent Canadian hospital enjoyed progressive growth and enlargement under his direction.

Having been Medical Officer to the London Scottish Regiment before coming to Canada, Major Pirie served with distinction during the first World War as Radiologist of the McGill General Hospital Unit, Canadian Expeditionary Force. During his service in France, he developed a resonance apparatus for the location of metallic foreign bodies.

His public service continued as a member of the Advisory Committee on Radiology, National Research Council of Canada, until 1938; one of the consultants to the Department of Pensions and National Health in Montreal and its hospital at Ste. Anne de Bellevue and as Mayor of his residential village, Baie d'Urfe, until shortly before his death.

The members of the American Roentgen Ray Society will long remember him for his keen scientific interest and comment on all

technical and interpretive developments, his "roentgenometer" for gauging the degree of accommodation of the eyes for the roentgenoscope, the demonstration of the fact that the retina is sensitive to roentgen rays—for which he was awarded the Society's Gold Medal in 1932—and especially the traditional singing of "Alouette," which "Sandy" led at the annual banquets.

His penchant for and curiosity in all the natural sciences was manifest by an active interest in ornithology and astronomy, the development of extensive gardens wherein he was wont to propagate special plants from seeds produced by selected flowers of the year before, "soil-less" culture of flowers, vegetables and shrubs brought from his Florida home to his "habitant" suburban home on Lac St. Louis and the recording of some of his impressions in wood-carvings.

These interests were enjoyed with him by Ethel Martin, daughter of an Ontario physician and an authority on the birds of eastern Canada, whom he married in 1903, but who died in 1938 after a prolonged illness, and the second Mrs. Pirie, Mary C. Sayer, whom he married late in 1939. Only three months before his death, the Pories had occupied their new country estate at Alstonvale on the Ottawa River, and had transplanted many of their flowers to bloom there.

Member of the American Roentgen Ray Society since 1912, President in 1927, and Life Member since 1943; member of the British Institute of Radiology; Fellow of the Royal Society of Medicine (London) and the British Faculty of Radiologists; one of the charter members of the Canadian Association of Radiologists; Canadian delegate to the International Congress of Radiology (London, 1925 and Stockholm, 1928), Dr. Pirie contributed much to the development of radiology, especially in Canada.

He was a sincere and loyal friend, who will be greatly missed by his colleagues.

CARLETON B. PEIRCE

# SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

*Items for this section solicited promptly after the events to which they refer.*

## MEETINGS OF ROENTGEN SOCIETIES\*

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*Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Netherland Plaza Hotel, Cincinnati, Ohio, Sept. 18-21, 1945.*

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#### RADIOLOGICAL SOCIETY OF NORTH AMERICA

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#### RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

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#### RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL ASSOCIATION

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*Secretary, Dr. Roy G. Giles, Temple, Texas.*

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*Secretary, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N.Y. Meets monthly on fourth Tuesday, October to April.*

#### BUFFALO RADIOLOGICAL SOCIETY

*Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.*

#### CHICAGO ROENTGEN SOCIETY

*Secretary, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.*

#### CINCINNATI RADIOLOGICAL SOCIETY

*Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.*

#### CLEVELAND RADIOLOGICAL SOCIETY

*Secretary, Dr. D. D. Brannan, 11311 Shaker Blvd., Cleveland 4, Ohio. Meets at 6:30 P.M. at Allerton Hotel on fourth Monday each month, October to April, inclusive.*

#### DALLAS-FORT WORTH ROENTGEN STUDY CLUB

*Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meetings held in Dallas on odd months and in Fort Worth on even months, on third Monday, at 7:30 P.M.*

#### DENVER RADIOLOGICAL CLUB

*Secretary, Dr. Edward J. Meister, 366 Metropolitan Bldg., Denver, Colo. Meets third Friday of each month at Denver Athletic Club.*

#### DETROIT ROENTGEN RAY AND RADIUM SOCIETY

*Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.*

#### FLORIDA RADIOLOGICAL SOCIETY

*Acting Secretary, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Fla. Meetings in May and November.*

#### GEORGIA RADIOLOGICAL SOCIETY

*Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.*

#### RADIOLOGICAL SOCIETY OF KANSAS CITY

*Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month at a place designated by the president.*

#### ILLINOIS RADIOLOGICAL SOCIETY

*Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.*

#### INDIANA ROENTGEN SOCIETY

*Secretary, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meets annually second Sunday in May.*

#### IOWA X-RAY CLUB

*Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.*

#### KENTUCKY RADIOLOGICAL SOCIETY

*Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.*

#### LONG ISLAND RADIOLOGICAL SOCIETY

*Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.*

#### LOUISIANA RADIOLOGICAL SOCIETY

*Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.*

#### MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

*Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.*

#### MILWAUKEE ROENTGEN RAY SOCIETY

*Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.*

#### MINNESOTA RADIOLOGICAL SOCIETY

*Secretary, Dr. Annette T. Stensstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.*

#### NEBRASKA RADIOLOGICAL SOCIETY

*Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.*

#### NEW ENGLAND ROENTGEN RAY SOCIETY

*Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.*

#### RADIOLOGICAL SOCIETY OF NEW JERSEY

*Secretary, Dr. H. R. Brindle, 501 Grand Ave., Asbury Pl. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.*

#### NEW YORK ROENTGEN SOCIETY

*Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 3:30 P.M.*

#### NORTH CAROLINA ROENTGEN RAY SOCIETY

*Secretary, Dr. Major Fleming, Rocky Mount, N. C. As-*

\* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

- annual meeting at time and place of State Medical Society.  
Mid-year scientific meeting at place designated.
- NORTH DAKOTA RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. L. A. Nash, St. John's Hospital, Fargo.  
Meetings held by announcement.
- CENTRAL NEW YORK ROENTGEN RAY SOCIETY**  
*Secretary*, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse.  
Three meetings a year. January, May, November.
- OHIO RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.
- PACIFIC ROENTGEN SOCIETY**  
*Secretary*, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.
- PENNSYLVANIA RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. L. E. Wurster, 416 Pine St., Williamsport.
- PHILADELPHIA ROENTGEN RAY SOCIETY**  
*Secretary*, Dr. R. P. Barden, University Hospital, Meetings first Thursday of each month from October to May inclusive at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.
- PITTSBURGH ROENTGEN SOCIETY**  
*Secretary*, Dr. L. M. J. Freedman, 4800 Friendship Ave. Meets second Wednesday each month, 4:30 P.M., October to June, Pittsburgh Academy of Medicine.
- ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.**  
*Secretary*, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.
- ROCKY MOUNTAIN RADIOLOGICAL SOCIETY**  
*Secretary* Dr. A. M. Popma, 220 N. First St., Boise, Idaho.
- ST. LOUIS SOCIETY OF RADIOLOGISTS**  
*Secretary*, Dr. E. W. Spinzig, 2646 Potomac, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.
- SAN DIEGO ROENTGEN SOCIETY**  
*Secretary*, Dr. Henry L. Jaffe, Naval Hospital, Balboa Park, San Diego, Calif. Meets monthly on first Wednesday at dinner.
- SAN FRANCISCO RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. Martha Mottram, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 P.M., first six months of year at Toland Hall, University of California Hospital, second six months at Lane Hall, Stanford University Hospital.
- SHREVEPORT RADIOLOGICAL CLUB**  
*Secretary*, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.
- SOUTH CAROLINA X-RAY SOCIETY**  
*Secretary*, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.
- TENNESSEE RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.
- TEXAS RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. Asa E. Seeds, Baylor Hospital, Dallas, Texas. Next annual meeting, Temple, Texas, Jan. 17, 1945.
- UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING**  
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.
- UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE**  
*Secretary*, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00-5:00 P.M., Room 301, Service Memorial Institute.
- VIRGINIA RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.
- WASHINGTON STATE RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

**X-RAY STUDY CLUB OF SAN FRANCISCO**  
*Secretary*, Dr. J. M. Robinson, University of California Hospital. Meets monthly, third Thursday evening.

#### CUBA

**SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA**  
*President*, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

#### BRITISH EMPIRE

**BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY**  
Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

**SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)**  
Meets on the third Friday of each month at 4:45 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.

**FACULTY OF RADIOLOGISTS**  
*Secretary*, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.

**SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS**  
*Secretary*, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

**RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION**  
*Secretary*, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

**CANADIAN ASSOCIATION OF RADIOLOGISTS**  
*Secretary*, Dr. A. D. Irvine, 540 Tegler Bldg., Edmonton, Alberta.

**SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION**  
*Secretary*, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

**RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION**  
*Secretary*, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

#### SOUTH AMERICA

**SOCIEDAD ARGENTINA DE RADIOLOGIA**  
*Secretary*, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

#### CONTINENTAL EUROPE

**SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA**  
*Secretary*, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

**SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)**  
*Secretary* for French language, Dr. A. Grosjean La Chaux de Fonds.  
*Secretary* for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.

**SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE**  
*Secretary*, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

**ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD:**  
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.  
*Secretaries*, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

**LENINGRAD ROENTGEN RAY SOCIETY**  
*Secretaries*, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

**MOSCOW ROENTGEN RAY SOCIETY**  
*Secretaries*, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

**SCANDINAVIAN ROENTGEN SOCIETIES**  
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

### THREE YEAR ROTATING SERVICE IN RADIOLOGY

The Peter Bent Brigham Hospital in Boston is announcing a three year rotating internship and residency in Radiology which began July 1, 1944. The service will include roentgenological training in Pediatrics and Obstetrics under Dr. E. B. D. Neuhauser at the Children's Hospital and Boston Lying-in Hospital, in pathology under Dr. Shields Warren at the Deaconess Hospital, and in Roentgen and Radium Therapy under Dr. Joseph H. Marks at the Deaconess Hospital. The initial six months and the final year of the combined service will be spent at the Peter Bent Brigham Hospital under Dr. Merrill C. Sosman. In individual cases where the candidate has had a thorough training in Pathology before starting this service, special arrangements can be made for study and original work in Radiation Physics, Nuclear Physics or Bio-Physics with radioactive tracers, either at Harvard University or Massachusetts Institute of Technology.

As soon as Procurement and Assignment will permit, two men will be accepted each year, one each on January 1 and July 1. Stipends of \$500 the first year, \$750 the second year and \$1,000 the third year are paid, in addition to board, room, uniforms and laundry, or commutation for quarters, during each period. All of the hospitals are closely grouped around Harvard Medical School and all partake in the teaching of undergraduates and post-graduates in the School.

This combination of men and of hospital departments should do much to improve the basic training in Radiology and should help insure a continued output of well grounded young roentgenologists, for whom there is such a demand at present. The plans permit expansion to accommodate returning Service men who may desire a shorter period of training or review in parts of the field, as well as those who wish to complete the training which was interrupted by entry into the Services.





## DEPARTMENT OF TECHNIQUE

*Department Editor:* ROBERT B. TAFT, M.D., B.S., M.A., 103 Rutledge Ave.  
Charleston, S. C.

### A METHOD OF FOREIGN BODY LOCALIZATION USING TWO PARALLEL ROENTGEN FILMS

By SIEGFRIED W. WESTING, M.D.

*Roentgenologist, Brooklyn Cancer Institute, Department of Hospitals,  
NEW YORK, NEW YORK*

THROUGH an article by Ashwin<sup>1</sup> I learned of a foreign body depth determination which impressed me as remarkably simple and new. On two parallel films make exposures from two different tube positions. On paper (see Fig. 2; solid lines) draw two horizontal lines, the distance of which equals the distance between the films. These lines are crossed by a vertical line. Starting at the vertical line enter on one of the horizontal lines the shift of the foreign body shadows, as visible on one of the films, and obtain point *K*. Repeat the procedure, using the other horizontal line and the other film, and obtain point *K'*. The extension of line *KK'* crosses the vertical line at *N*. The distance between *N* and the nearer horizontal line equals the distance between the foreign body and the film nearer the skin.

The determination of the depth of a foreign body—although always valuable and in certain cases sufficient—does not constitute a complete localization. In order to obtain complete localization one has to determine—in addition to the depth—the projection of the foreign body on the skin. Ashwin's procedure, notwithstanding the title of his article "A practical localisation method," requires supplementary steps before a localization method is obtained.

I have amplified Ashwin's procedure and thus developed a localization method which requires no special equipment, no arithmetic

calculations, can be accomplished speedily and with minimal handling of the patient, and without roentgenoscopy. I understand that in hospital tents roentgenoscopy is not a simple matter during daylight. All that is necessary is two exposures on two parallel films and the drawing of a few straight lines on a sheet of paper.

The method calls for the following eleven steps:

(1) One film wrapped in a lightproof envelope is placed adjacent to the area to be examined. A second film in the same kind of envelope is held parallel to the first by a block of radiotransparent material (for instance, wood). Mark the second film "FAR," placing the letters as they appear in ordinary script, not mirror script.

(2) Measure the distance between the two films. This is the only measurement necessary. After this measurement has been performed once, it can be used for all subsequent localizations. This measurement has to be as accurate as possible.

(3) Adjust the roentgen tube as for an ordinary exposure. The anode film distance is optional.

(4) On the skin draw in ink a clock hand: the base of the clock hand at the point of incidence of the vertical ray; the point of the clock hand indicating the direction of the tube shift to be done later. Place a wire of identical shape and direction on the ink mark.

(5) Make the exposure. Shift the tube. (Amount of shift is optional. Direction of shift is optional as long as it is not straight toward or straight away from the foreign body. Any side shift will do. Direction has to conform to direction of ink-wire marker.) Make the second ex-

<sup>1</sup> Ashwin, C. Practical localisation method. *Radiography*, Lond., 1944, 10, 6-7.

posure on the same two films. The patient has to keep motionless during the entire step (5).

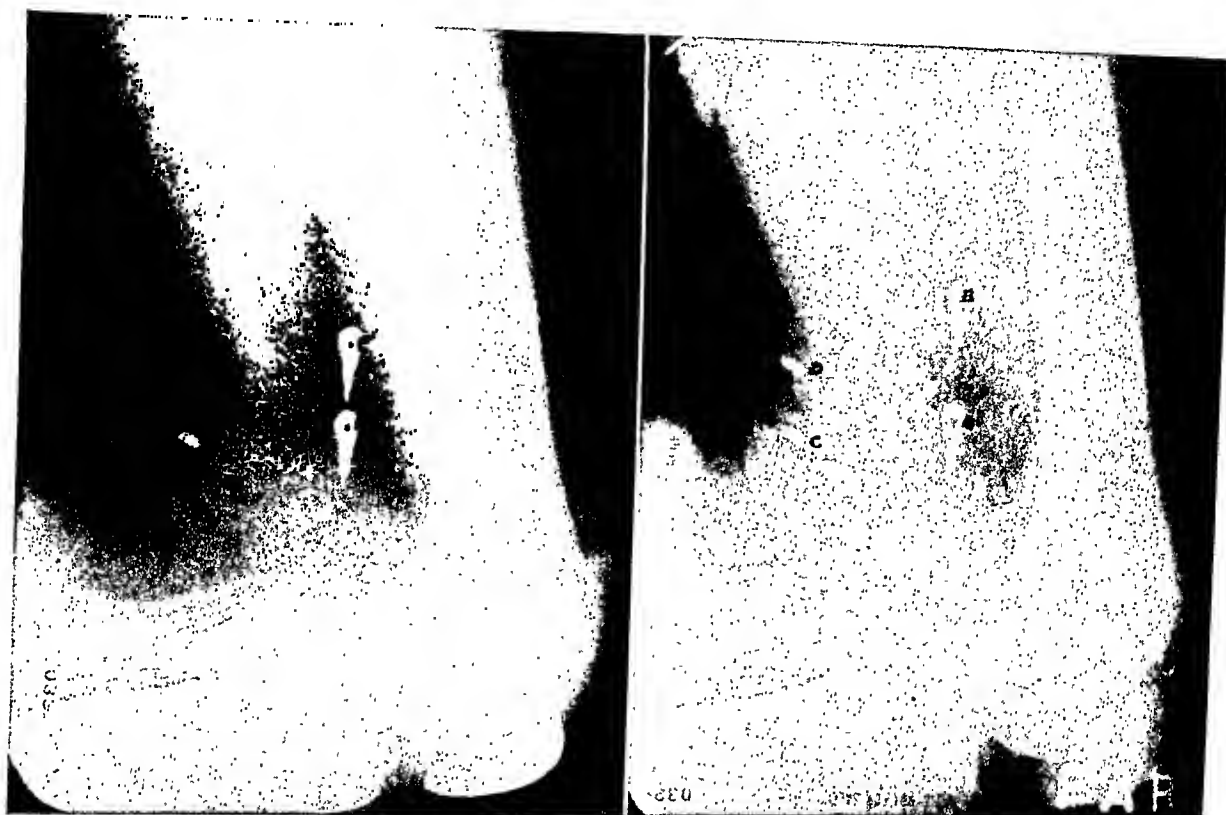
(6) On paper (see Fig. 2) draw two parallel lines at a distance *exactly* equal to the distance between the films. Let these lines be crossed by a vertical line.

(7) After processing the films, hold the far film so that the word FAR will appear as ordinary script, not mirror script (see Fig. 1). Two shadows of the clock hand and two shadows of

vertical line at *N* and *O*. Draw line *MM'* and the horizontal line through *N*; these lines cross at *P*.

(10) On the far film determine the direction of *AC*. If the wire marker and its shadow are assumed to be a clock hand pointing to 12 o'clock, the direction of *AC* can be described as the hour which would be indicated by the clock hand in this direction.

(11) The localization can now be reported: Place the part examined so that the skin carry-



NEAR FILM

FAR FILM

FIG. 1. Knee in maximal flexion. One metallic foreign body concealed in knee cavity. Factors: 68 kv., 10 ma., anode distance from near film 27 in., from far film 29 in. Tube shift 5 in. A  $15^\circ$  cone tilt was employed during the second exposure. Time:  $2\frac{1}{2}$  seconds for each of the two exposures.

the foreign body will be seen. Of each shadow pair, consider first the shadow nearer the side to which the arrow points. Call the base of the first clock hand shadow *A*, of the second *B*; call one point of the first foreign body shadow *C*, and the identical point of the second foreign body shadow *D*. On the lower horizontal line, always starting at the vertical line, enter accurately *CD*, *AB* and *AC*. Thus the points *K*, *L*, and *M* will be obtained.

(8) Repeat step (7) using the near film with points *E*, *F*, *G*, *H* and upper horizontal line, thus obtaining the points *K'*, *L'*, *M'*.

(9) Draw lines *KK'* and *LL'* which cross the

ing the ink drawing forms the upper surface. Assuming that the clock hand points to 12 o'clock, proceed toward — o'clock (direction *AC* determined on far film; 2:30 o'clock in this case) for — inches (equal to *NP*;  $1\frac{3}{8}$  inches in this case). Thus the skin point vertically above the foreign body is arrived at. The foreign body is — inches (equal to *ON*;  $2\frac{3}{8}$  inches in this case) vertically below this point. If operation is contemplated and the position during the intended operation is going to differ from the position just described, it may be advisable to repeat the localization in the position of the intended operation.

Ashwin makes the statement that to the best of his knowledge, his method has not previously appeared in *Radiography*. I have made a search of the literature and I have been unable to find the method published anywhere.

and have found it to yield a satisfactory degree of accuracy. At depths up to 6 inches an error of about  $1/16$  inch was observed; the range of error was even less with regard to the determination of the skin point vertically above the foreign body. Al-

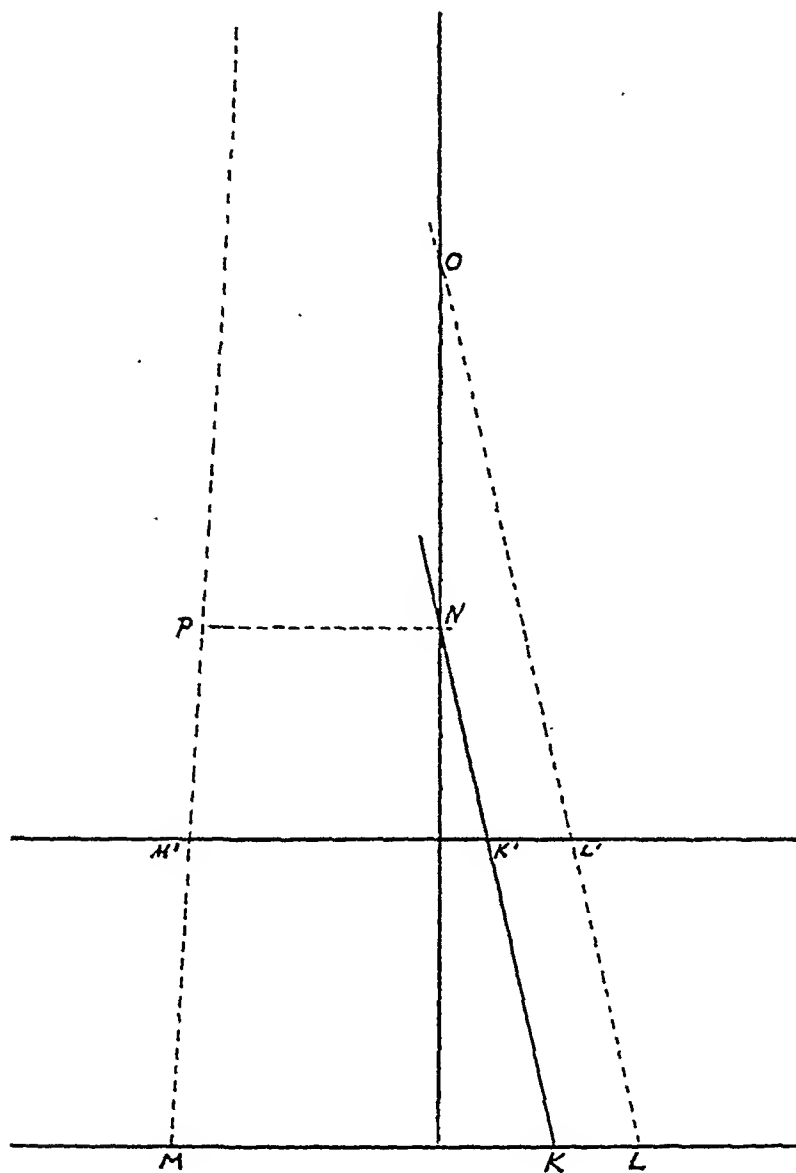


FIG. 2.

The method is applicable chiefly to not too heavy parts of the body. Should the method come into extensive use, manufacturers may undertake the production of suitable cassettes, plainly marked with the distance between the films and supplied with intensifying screens so that the method may also be employed for heavier parts.

The method presupposes that the upper surface of the body part under examination is horizontal or nearly so. I have used the method in the case of foreign bodies concealed in the knee cavity and on phantoms,

though the method is very simple, it may be well to practice the method and check the results on a phantom before carrying out the actual localization.

#### ADDENDUM

##### *Mathematical Proof of Ashwin's Depth Determination*

I have worked out mathematical proof of Ashwin's principle and of my modified procedure and I am appending the proof for those interested in this phase of the problem.

Consider the situation which exists when two unselected exposures are made of a foreign body on two films, whose distance is  $a$ . The dis-

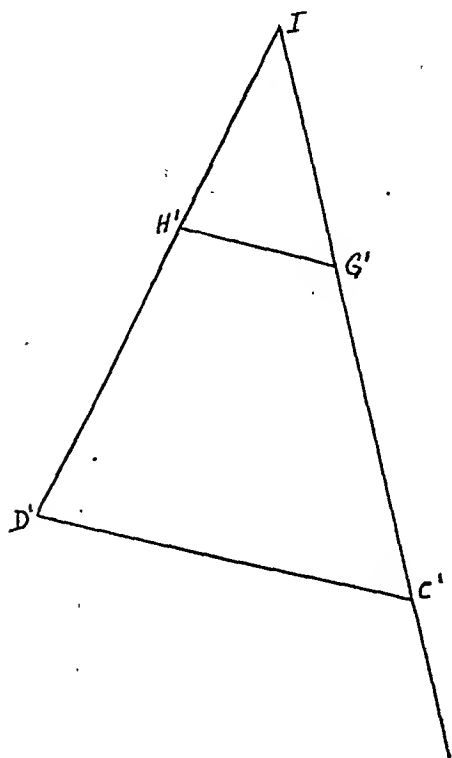


FIG. 3.

tance from the foreign body to the nearer film is  $f$ . One exposure creates foreign body shadows  $C'$  on the far film and  $G'$  on the near film, the other  $D'$  and  $H'$ . The lines  $C'G'$  and  $D'H'$  cross

Next consider the plane which contains the line  $IG'C'$  and the plumb line dropped from  $I$ . The plumb line crosses the films at  $Q$  and  $R$ .  $IQ=f$  and  $QR=a$ . This plane crosses the two parallel films in two parallel lines. One of these lines contains  $G'$  and  $Q$ , the other  $C'$  and  $R$ .  $G'Q \parallel C'R$  (see Fig. 4).  $IG'/IC' = IQ/IR$  and, as shown above,  $= G'H'/C'D'$ .

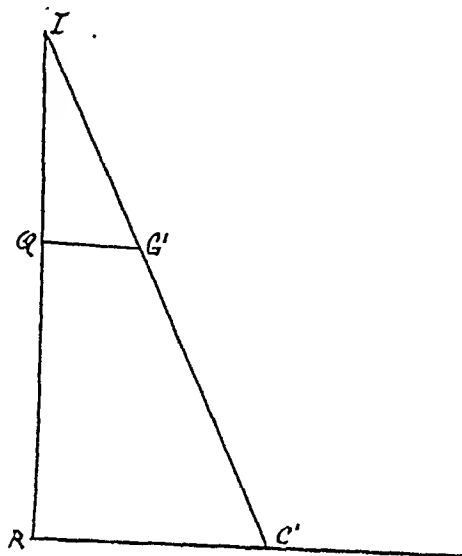


FIG. 4.

$C'D'$  and  $G'H'$  are the shadow shifts. If different tube positions are used, a plane different from our first plane will result. In this plane the shadow shifts will have a length different from

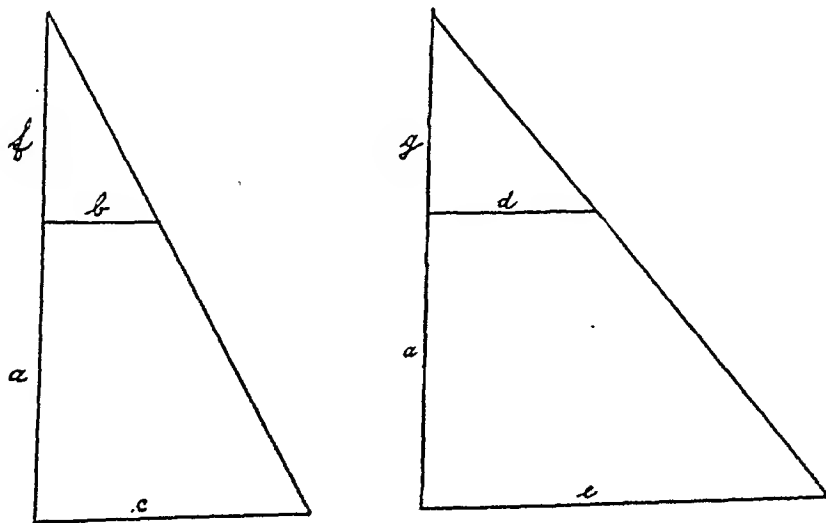


FIG. 5.

at the foreign body,  $I$ , and are located in one plane. This plane crosses the films in two parallel lines. One of these parallel lines contains  $C'$  and  $D'$ , the other  $G'$  and  $H'$ .  $C'D' \parallel G'H'$  (see Fig. 3).  $G'H'/C'D' = IG'/IC'$ .

$C'D'$  and  $G'H'$ , but the relation between the two new shadow shifts will likewise be equal to  $IQ/IR$ . No matter which two-tube positions are considered, the relation of the resulting shadow shifts will invariably be equal to  $IQ/IR$ .

Let us call one pair of shadow shifts  $b$  and  $c$ , another one—produced by the same foreign body on the same films— $d$  and  $e$ .  $b/c = d/e$ .

When each pair of shadow shifts is entered on a separate Ashwin line system (two horizontal, one vertical) (see Fig. 5), the following equations will result:  $b/c = f/(f+a)$  and  $d/e = g/(g+a)$ . As shown above,  $b/c = d/e$ , therefore  $f/(f+a) = g/(g+a)$ . Therefore  $f = g$ . This means that entering on Ashwin's line system a pair of shadow shifts produced by one foreign body on one pair of films will always result in a line which has the length  $f$ .

The equation  $f/(f+a) = b/c$  can be used to find  $f$  by calculation instead of drawing.

#### *Mathematical Proof of the Present Modified Procedure*

Consider the situation which exists during the first exposure as described in the first five directions. The vertical ray is a line which connects the anode, the skin marker,  $J$ , its shadows  $E$  and  $A$ .  $AE = a$ , the distance between the films. The line which connects the foreign body shadows  $C$  and  $G$  passes through the foreign body,  $I$ , and crosses the first line at the anode. Both these lines are located in one plane, called hereafter "our plane." Our plane crosses the two films at right angles and in two horizontal lines. One of these lines contains  $A$  and  $C$ , the other  $E$  and  $G$ .  $AC \parallel EG$ . The vertical ray forms right angles with any line on the two parallel planes which passes through  $A$  or  $E$ . The vertical ray forms right angles with  $AC$  and  $EG$ . Since our plane crosses the skin at right angles, the vertical line from the foreign body to the skin is located in our plane. The intersection of this vertical and the skin is called  $S$ . Our plane crosses the upper skin surface in a horizontal line. This line contains  $J$  and  $S$ .

If one draws two parallel lines whose distance is  $a$  and lets them be crossed by a vertical line (see Fig. 6), he may consider these lines a reproduction of the vertical ray and of the crossing lines of our plane and the films. The crossing points of the vertical and the horizontal lines are reproductions of  $A$  and  $E$ . It is permissible to enter  $AC$  and  $EG$  on the horizontal lines. Point

$I$  must lie on the extension of  $CG$  and at distance  $f$  from  $EG$ , that means at the intersection of  $CG$  and a line running at distance  $f$  parallel to  $EG$ . This line crosses the vertical line at  $T$ .  $J$  is found through Ashwin's procedure whereby the shadow shifts of the skin marker are used.  $S$  is found as the intersection of a vertical extending from  $I$  and a horizontal running

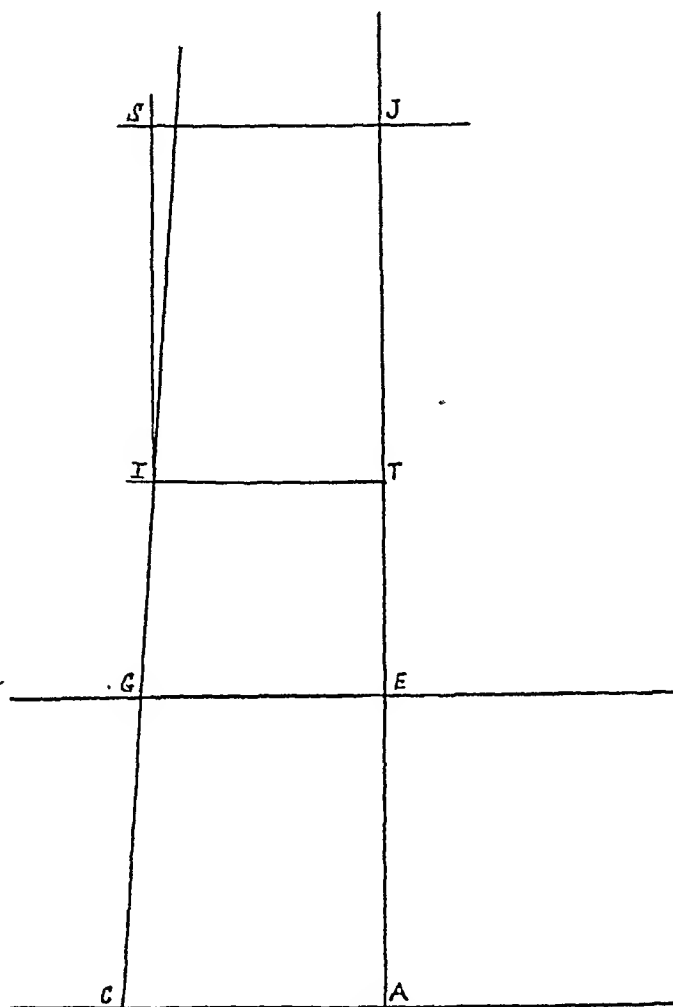


FIG. 6.

through  $J$  and representing the crossing line of the skin and our plane.  $SJTI$  is a rectangle.  $SJ = TI$ . Since Figure 6 turns out to be a true replica of Figure 2, it is proved that  $NP$  is equal to the distance between the skin marker  $J$  and the projection of the foreign body on the skin  $S$ . Since  $J\bar{S}$  is parallel to  $AC$ , the direction of  $J\bar{S}$  on the skin is identical with the direction of  $AC$  on the far film.

180 Lenox Road,  
Brooklyn, N. Y.



# A DEVICE FOR COMPRESSION POLYGRAPH STUDIES OF THE GASTROINTESTINAL TRACT

FEBRUARY, 1945

By ALEXANDER LEWITAN, M.D.  
BROOKLYN, NEW YORK

TO RECORD roentgenoscopic observations instantaneously, Berg introduced a spot film compression device into the

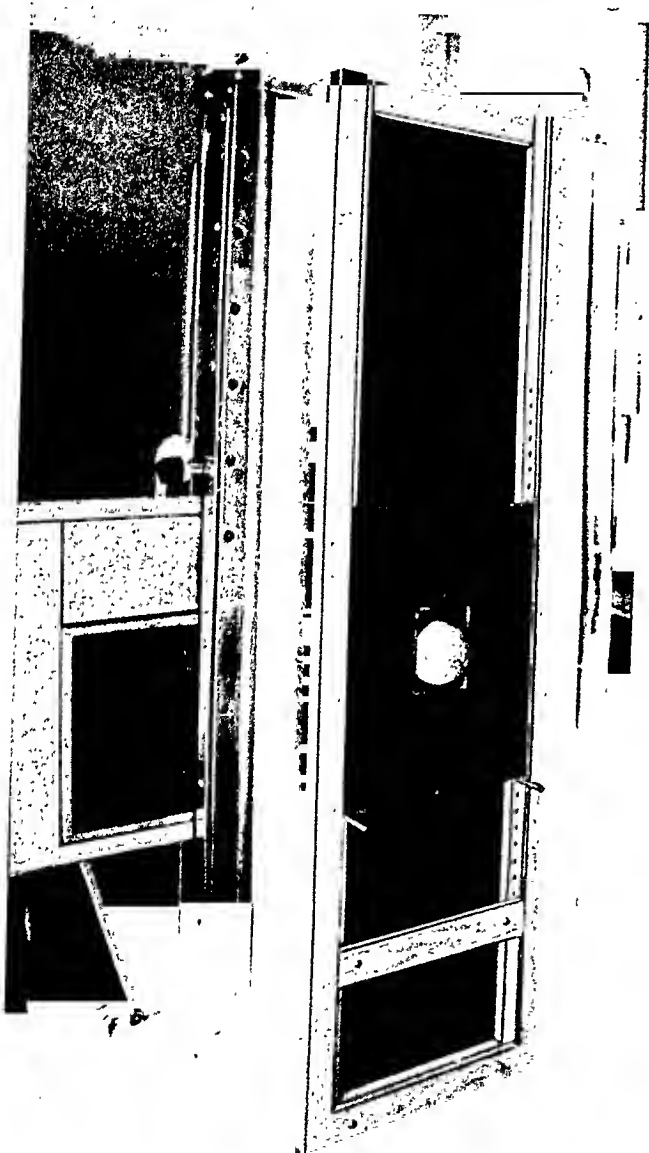


FIG. 1. The hanging frame, cut-out lead shield with compression cup in the erect position ready for use.

roentgenography of the gastrointestinal tract. However, most of the roentgen apparatus does not lend itself easily to the installation of this equipment, which, in

addition, is quite expensive. A substitute for the spot film compression device consisting of compression polygraphs has proved very satisfactory, and a home made apparatus was constructed for this purpose.

A home made Bucky polygraph, which was described by Nathanson and Wittenberg,<sup>2</sup> was further developed so it could be utilized to obtain compression polygraph studies in the erect and prone positions.

The cut-out lead shield and wooden frame for the Bucky polygraph were made according to the specifications in the previously mentioned article. An aluminum cup which fits snugly into the opening of the lead shield was added for compression purposes. In order to use the lead shield in the erect position, two wooden bars which are connected by crossbars were constructed. These bars contain a channel  $\frac{1}{2}$  inch deep in which the lead shield moves freely. Openings are provided within the bars 1 inch apart. The lead shield is inserted from the top, and at the desired level it is held in place by two wooden pegs or screws which fit into the openings. The length of the entire frame is 5 feet. Angle irons are attached to the top of the wooden frame which make it possible to lift the frame off the table easily.

To do an erect compression polygraph, the wooden frame is placed over the table, the lead shield is inserted from the top and secured at the desired level by the wooden pegs, and the compression cup is placed into the cut-out lead shield. The patient is then roentgenoscoped and the lead shield adjusted to the correct level under roentgenoscopic control. Compression polygraphs can now be taken. The patient is instructed to rest against the cup, to use



slight pressure, to press hard, and very hard. Thus four roentgenograms are obtained with a varied degree of compression.

in the erect position, but a varied amount is also obtained by instructing the patient to use a varied amount of pressure. The



FIG. 2. Prone compression polygraph of the duodenal bulb in a case showing a residual ulcer crater with convergence of the mucosal folds in an undeformed duodenal bulb.

In the prone position the wooden frame is unnecessary. The cut-out lead shield and compression cup are only needed to obtain the compression studies. However, compression cannot be regulated as easily as

roentgenograms obtained by this method have been very satisfactory, and it has been very gratifying to demonstrate pathologic conditions which otherwise would have been hidden. The goal of Berg<sup>1</sup> and Åker-



FIG. 3. Erect compression polygraph of the duodenal bulb in a case showing a minimal marginal deformity and distortion of the mucosal pattern. These cases illustrate the various degrees of compression which can be obtained with the device.

lund to use measured compression for mucosal studies of the gastrointestinal tract is accomplished by the aid of a very simple apparatus which represents a material cost of approximately five dollars, and can be attached to any roentgenographic table which has a Bucky tray.

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# ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

FEBRUARY, 1947

## ROENTGEN DIAGNOSIS

### HEAD

HARTLEY, J. BLAIR, and BURNETT, C. W. F.  
The radiological diagnosis of craniolacunias.  
*Brit. J. Radiol.*, April, 1943, 16, 99-108.

Craniolacunia is a developmental anomaly of the bones of the vault of the fetal skull. The bones at the base are normal. There are depressions on the inner surface of the bones of the vault, and in a more pronounced form, called craniofenestria, there are actual openings in the bones through which brain substance sometimes protrudes. This condition is usually associated with other defects, such as spina bifida, encephalocele, hydrocephalus or talipes.

If there is hydramnios or hydrocephalus during pregnancy an antenatal roentgen examination should be made for this condition. At birth its existence should be suspected in the presence of any of the above-named anomalies.

The author reviews 28 cases seen in a year's investigation, showing that the anomaly is much more frequent than has been believed. The lacunae tend to disappear as the child grows and the anomaly in itself does not constitute a danger to life. There is some evidence that it is familial or hereditary and it would be interesting to follow up these cases which might contribute valuable knowledge to the study of heredity.—Audrey G. Morgan.

### NECK AND CHEST

LINDSAY, JOHN R., TEMPLETON, FREDERIC E., and ROTHMAN, STEPHEN. Lesions of the esophagus in generalized progressive scleroderma. *J. Am. M. Ass.*, Nov. 20, 1943, 123, 745-750.

Generalized scleroderma is a systemic disease of the connective tissue. In most cases the process starts on the hands and feet. Three stages can be distinguished clinically: the edematous, the indurative and the atrophic stage. The initial edema does not pit on pressure. The skin appears tense and cannot be folded. In the second phase the skin hardens and stiffens. In the third stage the tips of the fingers become smaller and pointed, and the fingers are immobilized in

a flexed position. The face, the nose, the ears, and the lips become gradually smaller and thinner. All mucous membranes of the mouth may be involved in the indurative and atrophic process. Ulcers, probably due to tension and deficient circulation, develop mainly on the fingertips, the elbows and the ankles. Fibrosis of the lungs without any subjective symptoms is a common sign of the disease. Two types of the disease can be distinguished: the type starting with Raynaud-like signs and symptoms and the arthritic type, the latter starting with joint pains and stiffness. These two types are often intermingled.

Pathologically, the main feature of the disease is a peculiar change of the collagenous tissue usually designated as homogenization. After the edematous stage, with the picture of swollen and loose fibers, has subsided, the collagenous fibrillae become thickened and less acidophilic than normal. In this dense fibrous connective tissue the fibroblasts are shrunken and less numerous than normal. The vessels are intensely involved by a fibrotic process. The muscularis is completely replaced by connective tissue consisting of gross fibers.

*Lesions of the Esophagus in Generalized Scleroderma.* A review of the literature indicates that difficulty in swallowing has been reported in 16 cases of diffuse scleroderma. The authors report 5 cases which were clinically and histologically typical cases of diffuse scleroderma. They presented clinical evidence of a disturbance of the swallowing mechanism, varying apparently only in the stage of the esophageal lesion. A frequent complaint was of burning pain behind the sternum about an hour after meals, worse on lying down, probably due to regurgitation of gastric contents into the esophagus and resulting chronic esophagitis. Other esophageal symptoms consist of inability to swallow more than a few mouthfuls of fluid rapidly, difficulty in swallowing while lying down and a sensation of fullness behind the sternum or of a weight on the chest for a few moments after swallowing. These symptoms are explained by the roentgenoscopic observation that normal peristalsis is absent in the lower two-thirds of the esophagus and that the

contents accumulate in this relaxed and dilated portion. Propulsion of the bolus occurs mainly by gravity or by the transmitted effect of peristalsis in the upper end on repeated swallowing.

On roentgenoscopy 3 of the patients were found to have a localized narrowing of the esophagus about 4 or 5 cm. above the level of the diaphragm. In all 5 patients there were pronounced changes in the muscular movements. With the patient standing, barium sulfate passed from the pharynx to the stomach with some delay at the site of stricture but not at the cardia. When the patient was placed in the horizontal position the barium sulfate entered the esophagus and there remained. As each successive bolus was taken, the esophagus distended to receive it, reaching a width of approximately 4 to 5 cm. The primary peristaltic wave which normally arises in the pharynx and travels the length of the esophagus with each act of deglutition traveled only down to about the level of the suprasternal notch. If these patients were allowed to remain in the horizontal position after the esophagus filled and additional barium sulfate was given, barium sulfate entered the stomach. The amount of barium sulfate that entered the stomach with each act of deglutition seemed to be equivalent to the amount taken with each swallow.

Diffuse chronic esophagitis extending above the level of the aortic arch was a constant finding on esophagoscopy. This might be due to an inflammatory change in the mucosa comparable to that seen in the skin occurring on the basis of scleroderma or to a peptic esophagitis secondary to regurgitation and retention of gastric contents. Another esophagoscopic finding was that of chronic ulceration in the lower third of the esophagus down to the phrenic ampulla and stenosis at the upper limit of the ampulla. Roentgenoscopy indicated that the narrowing of the esophagus above the phrenic ampulla is constant. It is seen during expiration as well as during inspiration. The chronic ulceration was probably a direct result of the esophagitis, with sclerodermatic changes as a predisposing factor. The tendency toward stricture in these cases appears to be explained as a direct result of the chronic ulceration. The limitation of the stricture to the area of greatest ulceration just above the ampulla and the tendency of chronic ulceration in the esophagus at any level to produce stenosis support this view.—*S. G. Henderson*.

WILLIAMS, E. ROHAN. Dilatation of oesophagus. *Brit. J. Radiol.*, July, 1943, 16, 220.

The greatest degrees of dilatation of the esophagus are seen in cardiospasm. Sometimes in old cases the esophagus is not only dilated but elongated and becomes tortuous and kinked. Roentgenograms of 4 such cases are given and details of the roentgen appearances discussed.

The appearance of the dilated esophagus without contrast medium depends on its fluid content. In 1 of the above cases with a fluid content the esophagus is relatively opaque while in another almost entirely occupied by air the hypertrophied wall of the esophagus is clearly seen against the lung field. A clean-cut fluid level is seldom seen in plain roentgenograms, probably because of the collection of froth and lighter food materials at the top of the fluid column.—*Audrey G. Morgan*.

McLAREN, JOHN W. Kymography and its application to oesophageal movement. *Brit. J. Radiol.*, Sept., 1943, 16, 270-273.

It has been commonly supposed that food moves down the esophagus by peristalsis, that is, a coördinated reaction in which a wave of contraction preceded by a wave of relaxation passes downward, the food always entering a segment which has relaxed actively and enlarged to receive it.

The difficulties of screen observation and cinematography in studying the movements of the esophagus are pointed out and an analysis given of the movements of the esophagus by kymography with a fixed grid and moving film. Kymograms are reproduced and the method of transforming them to graphs showing the movements of the esophagus illustrated. These graphs show that a band of contraction passes down the esophagus at a speed that varies somewhat in different individuals. The average is about 3 to 3½ inches in two seconds. As the band contracts it may increase in length and appear to push the food along, but there is no band of relaxation preceding it. While negative pressure was not demonstrated, it is not inconsistent with the findings. There was no positive evidence of an eccentric wave of contraction. In one case in which there was a suggestion of it the kymograph was not good enough to be analyzed by this method. The findings show that the movement of the esophagus is of a different type from the classical peristalsis. None of the kymograms were good enough to permit

of analysis of the movements of the diaphragmatic opening. A further study should be made of the movements shown in pathological conditions.—*Audrey G. Morgan.*

TRIMBY, ROBERT H. Congenital laryngeal stridor; lack of relation to thymic diseases. *J. Am. M. Ass.*, July 10, 1943, 122, 740-742.

There exists a widespread tendency to place the blame for a respiratory abnormality of any magnitude in infancy on the thymus gland, particularly if there is roentgen evidence of thymic enlargement. Congenital laryngeal stridor, the most frequently encountered form of chronic stridor in infancy, has been recognized as an entity for many years. Although it is not often encountered, it is worthy of attention, since it is apt to cause anxiety owing to its being mistaken for some more serious disease.

The larynx is fully developed at birth and increases in size to puberty, with no sex difference noted in infancy. The structures about the upper aperture are soft and readily collapsible. The epiglottis, cartilages of Wrisberg and apexes of the arytenoid cartilage are composed of yielding, elastic cartilage. The rest of the larynx is of brittle hyaline cartilage. With the advent of direct laryngoscopy, the pathologic physiology of congenital laryngeal stridor was directly observed. McKenzie in 1925 reported direct laryngoscopic observations made by D. R. Paterson in which the latter saw "with each inspiration the soft parts of the cricoid, including the arytenoids and interarytenoid folds, 'disappear,' to so speak, into the interior of the larynx, being drawn downward and forward and to such an extent in pronounced cases that the upper border of the cricoid could be seen as a transverse ridge through the stretched mucous membrane." The sides of the orifice were also observed to be sucked in, and when he held one side up with forceps the noise stopped at once. Hill in 1930 described the situation as an exaggeration of the infantile type of larynx, differing from normal only in degree, and he believed that the stridor was probably due to the vibrations of the flabby epiglottis and unsupported arytenoepiglottic folds being sucked inward on inspiration. The pathogenesis described by McKenzie and by Hill seems fulfilled in cases cited by the author.

Although congenital laryngeal stridor is the most common cause of stridor in early infancy, it must be differentiated from other congenital

abnormalities which interfere with respiration, such as a small glottic lumen, congenital web below the glottis, micrognathia, macroglossia, laryngeal papilloma and cysts. Laryngeal spasm, perilaryngeal abscess, mediastinal tumor, foreign body and at times acute infections are important considerations. Simple thymic enlargement is rarely responsible for respiratory embarrassment in infancy.

Since congenital laryngeal stridor is usually outgrown, active therapy is seldom required.—*S. G. Henderson.*

KLEIN, NORBERT. Cervical sympathico-blastoma. *Brit. J. Radiol.*, June, 1943, 16, 183-184.

Malignant tumors originating from the cells of the sympathetic nervous system are generally found in the adrenals or in the retroperitoneal lymphatic glands. This article describes and illustrates a case in a boy of sixteen in which the primary tumor was on the right side of the neck near the angle of the jaw. Such cases of sympathicoblastomas originating from the cervical sympathetics are rare. There were numerous metastases in the bones of the shoulder girdle and in the skull. The former had resulted in a pathological fracture of the surgical neck of the left humerus which was the lesion that brought the patient for examination.—*Audrey G. Morgan.*

CAMPBELL, THOMAS A., STRONG, PAUL S., GRIER, GEORGE S., III, and LUTZ, RAYMOND J. Primary atypical pneumonia. *J. Am. M. Ass.*, July 10, 1943, 122, 723-729.

The purpose in this report is to emphasize the epidemiologic importance of primary atypical pneumonia, to consider its clinical features with special reference to the roentgenologic findings and to attempt to clarify the involved pathologic processes, omitting entirely the problem of etiology.

*Epidemiology.* It seems certain that the disease tends to occur both endemically and in minor epidemics. While the increased frequency with which roentgenograms have been taken recently has undoubtedly accounted for the recognition of many cases, there has been an actual increase in the incidence of the disease at the Army post from which this report comes as well as in neighboring civilian hospitals. The number of cases at this post increased from 17 in March to 105 in October. Because of the long



period of hospitalization this disease gives rise to a great loss of man-days and it therefore becomes of much military importance when it reaches epidemic proportions. Very few data were obtained on the incubation period of the disease, but most investigators estimate this period to be about seven to twenty-one days.

*Clinical Observations.* A gradual onset was noted in the majority of patients and was associated with prodromal symptoms of non-productive cough, low grade fever, muscular aching, malaise, headache and an occasional sore throat. The most common early symptom was a dry cough, which later became productive and often paroxysmal. Substernal soreness on coughing was a common and often distressing symptom. The most significant and frequently the only abnormal initial chest signs were suppressed breath sounds. The majority of the white blood cell counts were normal. A definite leukopenia was rare. No predominating pathogenic organisms were found in the sputum except in 3 instances, and these were all pneumococci of higher types which were considered to be without causative significance. All blood cultures were sterile. The temperatures on admission ranged from normal to 105° F., averaging 102° F., and fluctuated widely over twenty-four hour periods. The maximum fever was frequently reached within thirty-six hours after admission and terminated by lysis in about five days, regardless of the form of therapy. A few patients continued to have fever for as long as twelve to eighteen days. Spread of the disease process from one lobe to another or from one lung to the other was noted occasionally. The average period of hospitalization was twelve days, partially due to the necessity of keeping these patients in the hospital until they are ready to assume full military duty.

Sulfathiazole and sulfanilamide did not alter the course of the disease in any way. Routine therapy was supportive in nature and included bed rest, adequate fluids, antipyretics and sedatives.

*Roentgenologic Aspects.* An analysis of the roentgenograms demonstrated that 81 per cent of the pulmonary lesions were basilar, while 11 per cent of the cases showed involvement of the right upper lobe and in 5 instances were misdiagnosed as pulmonary tuberculosis. In 100 of these cases in whom adequate progress roentgenographic studies were made it was found that 57 per cent had cleared roentgenographi-

cally at the end of ten days, 85 per cent in twenty days and the remaining 15 per cent in the ensuing twenty day period.

Careful examination of the basilar shadows revealed a streaking type of density which radiated downward from the lung root and extended outward over the leaf of the diaphragm conforming to the general distribution of the bronchi. Superimposed on the stringy density was a mottled type of shadow which occurred in any part of the chest but was most commonly seen at the right cardiophrenic angle at or below the lung roots or along the left border of the heart. The mottled densities were interpreted as a lobular form of atelectasis based on a definite mechanical factor—the complete block of the smaller bronchi and bronchioles by collected exudate and swollen epithelium. It was thought that the stringy type of densities represented a combination of exudation within bronchi and bronchioles, swollen bronchial and bronchiolar epithelial lining, and peribronchial and peribronchiolar cellular infiltration. On rare occasions a complete lobe became atelectatic, and in these roentgenograms the shift of the mediastinum and the elevation of the diaphragm were pronounced. The collapsed lobe often simulated lobar pneumonia, but the diminished volume of the involved lobe, narrowing of the rib interspaces, shift of the mediastinum and elevation of the diaphragm revealed its true atelectatic nature. In many cases the mottled densities were seen to appear and disappear over night. The intermittent obstruction of the smaller bronchi and bronchioles was thought to be responsible for the transient pulmonary changes. One striking feature that was quite apparent in the majority of cases was the presence of horizontal linear densities overlying either diaphragm, usually after considerable clearing of the basilar shadows. These band densities had the appearance of the platelike atelectasis described by Fleischer and his associates.—*S. G. Henderson.*

SIMON, G. Some problems in connection with the early x-ray changes in adult pulmonary tuberculosis. *Brit. J. Radiol.*, July, 1943, 16, 217-219.

The author discusses a group of cases of adult tuberculosis in which there were no clinical signs and only slight roentgen signs. The lesions were of two types: (1) Round foci about 1 cm. in diameter or small smudges of

opacity, not so well defined. Both of these appearances were seen in the subclavicular region. (2) Mottled opacities of low density about 1-3 mm. in diameter below the clavicles or in the mid-zone. Such slight signs are often considered of no importance if there are no clinical signs but the author's material shows that while the round focus is comparatively benign if there are no clinical symptoms, a third of the smudge foci will progress to clinical tuberculosis and rather more than that of the mottled foci. In the cases that progress, present methods of treatment are inadequate and it is very important that these cases be brought to the attention of the clinician.

A more complete study should be made of the prognosis in the cases with only slight changes. A large series of cases should be reported by different authorities. Possibly a central registry similar to the American Bone Tumor Registry would be a good thing. More of these slight lesions than before have appeared since the introduction of mass roentgenography.—*Audrey G. Morgan.*

WARFIELD, CHESTER H. Types of pulmonary tuberculosis which demand disqualification for active duty in the Navy. *Radiology*, Sept., 1943, *41*, 282-283.

The object of this article is to acquaint civilian radiologists with the problems presented to radiologists in the Navy by the Bureau of Medicine and Surgery of the Navy Department and to enable them to explain to family and friends the reasons why some men without manifest lesions are returned home as unfit for service in the Navy.

All men, including officers, who present themselves for service in the Navy have a roentgen examination of the chest made. A 35 mm. film and the photofluoroscopic method are first used. This merely shows the presence of a pathological lesion, if any, and such lesions are overlooked in less than 1 per cent of the cases. If there is any pathological condition a 14×17 inch film is taken. If the lesion seen on the 35 mm. is confirmed the man is sent to the Naval Hospital for study and a decision as to what shall be done with him.

In April, 1941, the Surgeon General of the Navy outlined the following roentgen findings as sufficient cause for disqualification for service in the Navy: (1) any evidence of reinfection (adult) type tuberculosis, active or inactive, exclusive of slight thickening of the apical

pleura; (2) evidence of active primary (childhood) tuberculosis; (3) inactive primary pulmonary tuberculosis if the degree or extent of involvement appears to be of present or future clinical significance; (4) extensive multiple calcification in the lung parenchyma and massive calcification at the hilum; (5) evidence of fibrinous or serofibrinous pleuritis.—*Audrey G. Morgan.*

BRAILS福德, JAMES F. The radiographic postero-medial border of the lung, or the linear thoracic paraspinal shadow. *Radiology*, July, 1943, *41*, 34-37.

The author discusses work done on the linear thoracic paraspinal shadow at the University of Birmingham, Birmingham, England. This line is frequently seen on anteroposterior roentgenograms of the dorsolumbar area on the left side and less frequently on the right side. It extends upwards sometimes to the level of the fourth dorsal vertebra, but only as far as the reflection of the pleura on to the diaphragm, for it marks the postero-medial border of the lung and is caused by the sharp contrast between the relative radiotransparency of the lung and the opacity of the vertebral tissues to the rays. A diagram is given showing a transverse section of the body at the level of the ninth dorsal vertebra and the relationship of the postero-medial lung surface to the vertebrae. Tracings are also given from roentgenograms showing the postero-medial border of the lung in various conditions, including paravertebral abscess, hematoma associated with crush fracture of the eleventh dorsal body, osteochondritis of the dorsal spine and an abscess associated with collapse of the ninth vertebral body. In Paget's disease localized to one or more dorsal vertebral bodies the postero-medial border of the lung is deviated laterally by expansion of the bodies of the vertebrae. Any inflammatory or neoplastic change in the bodies of the vertebrae or the areolar tissue surrounding them may cause such deviations and it may be necessary to use other methods of examination to determine the cause of the deviation.—*Audrey G. Morgan.*

GARLAND, L. HENRY. The postero-mesial pleural line. *Radiology*, July, 1943, *41*, 29-33.

Several months ago an editorial appeared in *Radiology* which discussed the correct interpretation of a slender marginal line of demarcation which can sometimes be seen on sagittal roentgenograms of the lower posterior thorax, es-

pecially on the left side, though it may also appear on the right side. This editorial suggested that the line might be caused by an anomalous vessel.

Roentgen-anatomical studies by Lachman and a review of some cross-section anatomical texts have convinced the author that this line is not caused by an azygos vein but by a projection of the postero-mesial border of the lung and pleura and that it may therefore properly be called the postero-mesial pleural line.

Study of a number of cross-section anatomical texts showed that the border of the lung did lie in the sagittal plane at some level between the fifth and twelfth thoracic segments in about one-fourth of the cases.—*Audrey G. Morgan.*

SOSMAN, MERRILL C. The x-ray in curable heart disease. *Radiology*, Oct., 1943, *41*, 351-362.

Heart disease is generally considered incurable but it is of interest and value to physician, radiologist and patient to know that there are certain forms of heart disease that are curable by medicine or surgery. Three forms that are curable by surgery are heart disease due to hyperthyroidism, patency of the ductus arteriosus and chronic constrictive pericarditis. Three that can be relieved by medicine are beriberi heart disease, heart disease in acute nephritis and anemia, and in gummatous myocarditis. Cases of these different forms of heart disease are described and illustrated with roentgenograms. The clinical and roentgen signs are reviewed.

Heart disease due to hyperthyroidism shows marked hypoactivity on roentgenoscopy. The heart is usually considerably enlarged, rather triangular in shape like a medium-sized pericardial effusion, while the heart beat is indistinct and of small amplitude. These signs are overcome by treatment with thyroid extract. In patent ductus arteriosus the heart is usually enlarged, especially the left ventricle, the pulmonary artery is more prominent than usual, projecting anteriorly and to the patient's left, the hilar vessels are enlarged, especially on the right side, in less than half the cases pulsation of the hilar vessels can be seen roentgenoscopically, the so-called "hilar dance"; the left auricle was dilated posteriorly in nearly all of the author's cases; there is striking hyperactivity of the left ventricle and an associated increased expansile pulsation of the dilated pulmonary artery, synchronous with the hyperactive ventricular sys-

tole. These signs decrease after ligation of the ductus.

In constrictive pericarditis plaques of calcification can be demonstrated on roentgenoscopy; occasionally they dance with systole like a calcified heart valve. By rotating the patient it can be shown that the calcification is on the surface of the heart and not in its interior. The commonest places for calcification to occur are in the auriculoventricular sulcus, where it may form a complete ring around the heart, and on the diaphragmatic surface of the pericardium. Differential diagnosis from other similar conditions can be made by careful roentgen examination, particularly roentgenoscopy. In beriberi heart disease roentgen examination may show a hyperactive heart beat. If there is much edema there may be pericardial fluid which masks the heart beat. The amplitude of the beat on the right and left sides should be compared carefully in both posteroanterior and oblique positions. If pericardial effusion is suspected, it is important to compare the pulsation of the left ventricle with that of the aorta. The hyperactivity of the left ventricle may be masked by effusion but the expansion and collapse of the aorta may be definitely increased in amplitude.

The enlargement of the heart seen in acute nephritis may be due to hydropericardium or acute dilatation or both, while that in anemia is due to dilatation. In the latter case the heart will show hyperactivity of the myocardial beat. With treatment of the primary disease the heart will return to normal size, shape and activity. Heart failure due to pernicious anemia is also reversible. In gummatous myocarditis the roentgen changes are striking and the improvement after antisyphilitic treatment most marked.

Careful attention to detail in roentgen examination should be given in every case of heart failure in order to determine those cases in which successful treatment is possible.—*Audrey G. Morgan.*

#### ABDOMEN

WEINBERG, TOBIAS B., and RAIDER, LOUIS. Pedunculated tumors of the stomach prolapsing through the pylorus. *Radiology*, July, 1943, *41*, 52-55.

Pedunculated tumors of the stomach are of four types: solitary benign tumor, pedunculated carcinoma, part of a multiple polyposis and

prolapsed mucosa. These prolapsing tumors constitute a fraction of 1 per cent of all tumors of the stomach. They may prolapse through the pylorus into the duodenum.

There is no typical clinical picture. A characteristic roentgen finding is a filling defect, the location of which depends on the site of the polyp at the time of examination. Delayed emptying often results and there may be a considerable six hour residue. When the tumor is in the duodenum the pyloric end of the stomach appears normal.

A case is described in a man of seventy-five. When the first roentgen examination was made on April 3, 1941, the stomach was normal in size and position with no evidence of intrinsic disease. There appeared to be extrinsic pressure along the lesser curvature. There was a persistent rounded filling defect in the bulb of the duodenum. A diagnosis was made of polyp in the duodenum and extrinsic pressure on the stomach by the liver. The patient left the hospital but was readmitted November 7, 1941, with complaints similar to those on his first admission. But he had grown worse and had lost 15 pounds since his discharge. The roentgenogram now showed an irregular defect in the lesser curvature at the pyloric end of the stomach. A diagnosis was made of a mobile pedunculated polyp of the pylorus capable of prolapsing into the duodenum. The patient died on February 8, 1942, and autopsy showed a benign polyp of the pyloric region of the stomach. The liver was enlarged and full of nodules which were found on microscopic examination to be multiple primary carcinomata of the intrahepatic bile ducts.—*Audrey G. Morgan.*

### ROENTGEN AND RADIUM THERAPY

WASSON, W. WALTER. Intravaginal roentgen irradiation of cancer of the cervix. *Radiology*, May, 1943, 40, 454-457.

A new apparatus for intravaginal roentgen treatment of cancer of the cervix is described and illustrated. Cylinders made of brass are used to limit the distribution of the rays. The cylinders vary from 2 to 4 cm. in diameter and one is selected that fits the vagina to be treated. A proctoscopic light is fitted to the cylinder and the vagina inflated to place the cylinder properly. This apparatus can also be used in routine examination of the vagina.

The apparatus that contains the roentgen tube is brought into contact with the cylinder and clamped in position. A periscope is used for checking the position of the cylinder after the apparatus and the table are clamped in position. The procedure takes little more time than is required for the insertion of a vaginal speculum and causes the patient no discomfort. Any desired kilovoltage and any length of exposure can be used. The author has found that 200 kv. with the usual factors is the preferred voltage.

A diagrammatic sketch is given showing the relationship of the cylinders to the area treated and the uterine adnexa. This method makes cervical cancer a superficial lesion and makes uniform distribution of the irradiation in the female pelvis possible.—*Audrey G. Morgan.*

SCHMITZ, HERBERT E. Further study of super-voltage x-ray therapy in carcinoma of the cervix. *Radiology*, May, 1943, 40, 458-462.

It has been ten years since the first treatment of cancer of the cervix was given with 800 kv. maximum irradiation. The results of this treatment since that time are discussed and 2 cases reported in which unusual metastases occurred. The first case was in a woman of thirty-two who was treated by the supervoltage method for a carcinoma of the cervix of Grade 2 in 1935. The cervical lesion healed and she was well until December, 1941, when she returned complaining of cough and loss of weight. She died in January, 1942, and autopsy showed metastatic carcinoma of the upper lobe of the left lung, healed carcinoma of the cervix and metastatic carcinoma of the liver. The second case was in a woman of sixty-six treated in 1938 for a Grade 2 carcinoma of the cervix and in 1939 for a papillary growth in the anterior wall of the vagina. She remained well until October, 1941, when she returned complaining of a burning sensation in the region of the left scapula, precordial distress and pain in the left flank. She died with metastatic carcinoma of the liver, lung and brain.

Cervical carcinomas have always been thought to spread only through the lymphatics. But these cases show that when the patients survive for longer periods of time as they do with this treatment blood metastases occur to the bone, liver, lungs and brain and the more life is prolonged the more common such metastases will become.

Two hundred thirty-four patients with car-

cinoma of the uterus were admitted to the Gynecologic Service of the Mercy Hospital Institute from May, 1933, to January 1, 1938. Of these 72 were primary carcinomas of the cervix not previously treated. Of the 3 cases in clinical Group I all are alive after five years, of the 16 cases in Group II 50 per cent are alive, of the 32 cases of Group III, 43 per cent and of the 21 cases of Group IV, 9.5 per cent. The five year survival rate for the whole group is 37.5 per cent. These cases show that 75 per cent of cases of Groups I and II can be arrested but that the majority of cases do not come for treatment until they have reached Groups III and IV in which only 25 per cent can be arrested.—*Audrey G. Morgan.*

GARCIA, MANUEL. Tissue dosage in the control of carcinoma of the cervix. *Radiology*, May, 1943, 40, 463-473.

The author analyzes 191 cases of primary carcinoma of the cervix treated at the Charity Hospital, New Orleans, from April 1, 1938, to August 31, 1939. The absolute three year survival rate for the group was 37.7 per cent. Eight cases are eliminated because the data recorded were insufficient for calculation or because they were not treated. Two patients who died from complications of radium therapy were excluded. Among the 72 survivors 5 had recurrences before the end of the third year.

A combination of roentgen and radium therapy was used whenever possible. The question of specifying the dose in a common unit for all the qualities of radiation used so that the amounts used can be added is discussed. While both roentgen-ray and radium doses can be calculated in roentgens the doses in r cannot simply be added. Quimby has shown that the biologic effect is not a constant function of the amount of radiation when the average or effective wave length is changed. The best method is conversion of the computed doses to the equivalent amounts in one of the qualities used. Graphs are given showing the method of conversion and tables showing the doses attained.

It seems possible to give doses of radiation which are well tolerated and which give three year recovery in about three-fourths of Stage I and II cases and in nearly half of Stage III cases.—*Audrey G. Morgan.*

TRAUT, HERBERT F. Uses and abuses of radiation therapy in obstetrics and gynecology. *Am. J. Obst. & Gynec.*, 1942, 44, 638-647.

In this paper the author assesses the value of radiation therapy in obstetrics and gynecology from the more general point of view. He considers the subject from the standpoint of the age period in the life of a woman.

*Pre- and Postpuberal Period (first two decades).* (1) The use of irradiation should be confined to the treatment of the rare instances of malignant disease. (2) An active stand in restraining the use of the so-called "stimulating" or "temporary castrating" dose of radium or roentgen rays should be taken.

*The Reproductive Period (third and fourth decades).* (1) The treatment of carcinoma of the cervix constitutes the greatest use which can be made of irradiation during the reproductive period of life. (2) Very rarely may irradiation be indicated in a case of endometriosis. (3) The use of castration in treatment of cancer of the breast in women of reproductive age may be warranted. (4) Seldom will irradiation be the treatment of choice in a myoma occurring in this age period.

*Pre- and Postmenopausal Period (fifth and sixth decades).*

(1) Hyperplasia of the endometrium, endometriosis, the submucous myoma, and adenomyoma all may be treated efficiently by means of irradiation. Here, roentgen rays may be preferable to radium when there is danger of infection in the uterus or adnexal organs. Intracavitary radium in 1,400 to 1,600 mg-hr. doses is quicker and in many instances satisfactory.

(2) In treatment of pruritus of the vulva and anal region, roentgen treatment is not wise except perhaps in such small amounts as 75 r for five treatments. Irradiation may be followed by abnormal skin changes closely analogous to kraurosis.

*The Use of Radium and Roentgen Rays in the Treatment of Malignant Neoplasms.*

(1) Carcinoma of the vulva should never be treated by any form of radiation.

(2) In the treatment of carcinoma of the cervix, one of the most important recent improvements has been the application of deep roentgen therapy directly to the cervix and parametrium by means of the intravaginal cone.

(3) The lack of constant and competent gynecologic observation of women in the cancer age constitutes a terrible omission because such observation is the only way in which the early stages of the disease may be detected.

*Radiation Therapy in the Aged with Advanced Stages of Malignancy.*

(1) Sometimes marked regression of the malignant process results from treatment or pain is greatly relieved.

(2) Frequently, instead of giving comfort and prolonged life, irradiation produces nausea, vomiting, and added pain. Roentgen treatment of desperately ill or very aged patients with extensive metastatic disease is to be deplored with very few exceptions. It is a great mistake to conclude that all patients with inoperable or recurrent cancer should receive radiation therapy for often more harm than good is done.—*Mary Frances Vastine*.

SCHEFFEY, LEWIS C. Malignancy subsequent to irradiation of the uterus for benign conditions. *Am. J. Obst. & Gynec.*, Dec., 1942, 44, 925-951.

Of 481 patients with cervical carcinoma seen on the gynecologic ward service at Jefferson Medical College Hospital between 1921 and 1942, there were 7 who had received radiation therapy for an apparently benign condition, from two to eleven years prior to the diagnosis of malignancy. Conclusions relative to the cervix group are:

(1) All the patients were multiparas, ranging in age from forty-two to sixty-one. Treatment was for fibromyoma in 5 cases and for functional bleeding in 2 cases.

(2) Squamous carcinoma developed in every patient.

(3) There is no evidence to support a statement regarding the presence or absence of malignancy at the time of the initial irradiation, with the possible exception of the 1 patient in whom biopsy was performed. Errors of omission may be charged to the treatment of 6 of these patients when they were first seen. Interest was primarily centered on the fundal lesion.

(4) There is no substantial evidence to show that radiation therapy of the uterine fundus either retarded or accelerated the development of the cervical malignancy in these patients.

(5) *Whenever diagnostic curettage is indicated, the procedure might well be accompanied with cervical biopsy as a matter of record, but especially if any abnormality is apparent.*

Of 124 patients with fundal carcinoma seen during the same period, there were 13 who had received radiation therapy for supposedly benign lesions, from two to twenty-three years prior to the frank diagnosis of malignancy. Conclusions relative to the fundal group are:

(1) Nine of the patients were multiparas, 4

were nulliparas; the ages ranged from forty-three to seventy-one. Four patients were treated for fibromyomas, 5 for postmenopausal functional bleeding and 2 for typical hyperplasia.

(2) Adenocarcinoma was the diagnosis in 12 patients and myosarcoma in one.

(3) Carcinoma was perhaps present in 6 patients at the time of the initial irradiation therapy. In 4 patients in whom malignancy was discovered from ten to twelve years later, no errors of omission seem to have played a part.

(4) In only 2 instances is there factual evidence to indicate that radium may have retarded a malignant growth.

(5) *Radiation therapy should always be preceded or accompanied by diagnostic curettage.* Fibromyomas should never be regarded as the sole cause of postmenopausal bleeding until an accompanying adenocarcinoma of the endometrium has been ruled out. So-called functional or climacteric bleeding should be viewed with similar suspicion.—*Mary Frances Vastine*.

ALDRIDGE, ALBERT H. Intestinal injuries resulting from irradiation treatment of uterine carcinoma. *Am. J. Obst. & Gynec.*, Nov., 1942, 44, 833-857.

In this paper, the author's experience in the diagnosis and treatment of intestinal irradiation injuries at the Woman's Hospital for a five year period is recorded. Approximately 1 out of every 6 patients, or 16.9 per cent, treated for uterine carcinoma developed some degree of proved injury to the intestine. The total number of patients with intestinal irradiation injuries amounted to 38. Twenty-nine of these 38 cases had intestinal strictures.

Intestinal complications resulting from irradiation injuries include three characteristic types: (1) an acute localized proctitis or proctosigmoiditis; (2) ulceration of the mucosa and wall of the intestine; (3) formation of varying amounts of perirectal fibrous tissue.

*Acute localized proctitis or proctosigmoiditis.* Characteristic intestinal symptoms appear during the course of treatment or soon after its completion. There is a localized inflammatory process involving the anterior wall of the rectum and distal end of the sigmoid at about the level of the cervix. The symptoms disappear soon after termination of radiation therapy leaving no evidence of damage to the mucosa or wall of the intestine.

*Ulceration.* The symptoms of ulceration make



their appearance at any time from soon after termination of radiation therapy to within several weeks or months later. They tend to heal slowly and when healing is complete the mucosa is pale and atrophic in appearance.

*Perirectal involvement.* In this type of reaction, a diffuse mass of fibrous tissue involving all the pelvic structures below the uterocervical junction and extending upward and backward to the second or third sacral vertebra is formed. This manifestation of irradiation reaction is difficult to differentiate from the so-called "frozen pelvis." Intestinal obstruction is apt to be the final result.

It is frequently difficult to differentiate between intestinal obstruction caused by tissue reaction to irradiation injury and conditions resulting from malignancy.

In conclusion, it is noted that sufficient irradiation to effect a cure of uterine carcinoma cannot be applied without some damage to the intestinal tracts of a considerable percentage of patients treated. The development of intestinal symptoms and especially those of intestinal obstruction at any time from a few weeks to several years after irradiation for uterine carcinoma should always suggest the possibility of a post-irradiation intestinal injury.—*Mary Frances Vastine.*

WARD, GEORGE GRAY. The diagnosis and treatment of carcinoma of the corpus uteri based on experiences at the Woman's Hospital. *Am. J. Obst. & Gynec.*, 1942, 44, 303-309.

The series includes 192 cases of carcinoma of the corpus uteri observed during the period from 1919 to 1941 inclusive. Ewing's classification was employed in the histopathological grading of these carcinomas:

Grade 1. Superficial papillary adenoma malignum.

Grade 2. Adenoma malignum.

Grade 3. Adenocarcinoma.

Grade 4. Diffuse anaplastic carcinoma.

Grade 1 is of low malignancy while Grade 4 is very malignant, anaplastic, and consequently radiosensitive.

*Symptoms.* Metrorrhagia, spotting or a blood-tinged watery malodorous discharge was the predominant symptom occurring in 95 per cent of the cases.

*Diagnosis.* Curettage is necessary as microscopic examination of the growth is essential for the diagnosis. (It was noted that the passage of

the uterine sound produced profuse bleeding which was absent in normal cases.)

*Prognosis.* Grades 1 and 2 give a high percentage of cures if they are treated in the early stages. The prognosis is more grave in Grades 3 and 4. The time lost before the patient seeks relief for the irregular bleeding or discharge has been estimated to average seven to eleven months.

*Treatment.* (1) Surgery plus irradiation is the treatment of choice. Intracavitary irradiation at the same time the preliminary diagnostic curettage is performed should be done. The author inserts two 50 mg. capsules of radium in tandem formation with 1 mm. of platinum and rubber screening in the fundus. If the diagnosis is "malignant," a dosage of 2,400 to 4,000 mg-hr. is given. The operation is done four to six weeks subsequent to this. (2) 53.6 per cent of this series of cases were poor operative risks so irradiation alone was done in these cases. Repeated irradiation is advisable, a dosage of 2,400 to 4,000 mg-hr. being given at four week intervals. Whenever feasible, deep roentgen therapy should precede or follow the intracavitary treatment. (3) In the cases in which both the cervix and corpus uteri are involved, treatment should be that of carcinoma of the cervix.

*Results.* (1) Operable cases of corpus carcinoma treated by irradiation, surgery and roentgen rays should average 70 per cent five year survival. (2) Inoperable cases with irradiation alone should show an average five year survival of 35 per cent.

(In view of the more frequent association of carcinoma with fibromyoma—35 to 40 per cent—it is best to remove the entire uterus in all such cases. The removed specimen should always be opened at the time of operation so that a carcinoma of the corpus will not be overlooked.)—*Mary Frances Vastine.*

JUDD, EDWARD S., JR., and PRIESTLEY, JAMES T. Treatment of gastric ulcer. *Surg., Gynec. & Obst.*, July, 1943, 77, 21-25.

There are many points brought out in this article which should prove of interest to the roentgenologist, viz.:

1. Approximately 7 per cent of patients who undergo resection for malignant growths of the stomach are less than forty years of age.

2. Eighty per cent of patients who have gastric resection for malignant tumors and who previously received medical treatment for

presumed benign ulcer experienced temporary relief from this form of therapy.

3. Approximately 1 of 5 patients who has gastric resection performed for cancer has normal or elevated values for gastric acids.

4. Although 9 out of 10 benign gastric ulcers which are removed surgically are smaller than a quarter, it has been noted that approximately one-fifth of the carcinomatous lesions removed from the stomach have an area of ulceration 4 cm. or less in diameter.

5. Over a period of many years at the Mayo Clinic the diagnosis of gastric ulcer has been made by the roentgenologist in approximately 10 per cent of cases in which resection has been performed for actual carcinoma.

6. The only method of certain differential diagnosis between benign and malignant gastric ulcer is prolonged observation under medical treatment. Such observation should be carried on (intermittently following the first several months) for a period of at least several years.—*Mary Frances Vastine.*

ELLIS, F., WILSON, C. W., DOBBIE, J. L., GRIMMETT, L. G., and GREEN, ANTHONY. Beam direction in radiotherapy; symposium. *Brit. J. Radiol.*, Feb., 1943, 16, 31-43.

As the volume of tissue irradiated decreases the dose tolerated by that volume increases. In order to reduce the constitutional effects and increase the local dose, dosage must be very accurate. This can be accomplished by a number of devices for accurate beam directioning. A number of these are described and illustrated, showing their method of application. The entrant and emergent ray method is described which utilizes a surface body mark on each side of the tumor for localizing purposes. The directional caliper used in this method is illustrated. If the depth of a tumor below a given skin point is known and the point of entry of the beam is known, the required direction of the beam and the depth of the tumor can be determined by completing a parallelogram. A pocket instrument for such parallelogram determination is described and illustrated. The arc and pointer method for localizing foreign bodies was worked out in World War I. The same principle can be applied to beam directioning for tumors and the method is described and two arc beam directors are illustrated. An ideal method of irradiating a block of tissue uniformly is to place the tissue inside a three- four- or five-sided figure and

compound a series of isodose charts to secure uniformity. Such shapes for the marking out of fields are shown.

If pressure is exercised on a roentgen-ray applicator so that it is squeezed closer to the tumor, it is obvious that the dosage to the tumor is increased with the same skin dose. A method for accurately directing and measuring such compression is shown, as is also a method of keeping the patient motionless during treatment. A longitudinal steel bar is screwed to the side of the treatment couch. A master clamp moves along this bar and can hold various types of body supports for holding the patient in different positions according to the type of application of the rays.—*Audrey G. Morgan.*

QUICK, R. S., and ROBERTS, J. E. Short distance x-ray therapy with standard apparatus; physical factors. *Brit. J. Radiol.*, March, 1943, 16, 82-85.

The Siemens Chaoul tube and the Philips Metalix tube have been designed for the treatment at low voltages and short focus-skin distances of lesions on the skin or in body cavities. These treatments can be carried out, however, with simple modifications of the standard apparatus. There are lesions, however, in which the lethal dose should reach depths of 1 to 2 cm. and the overlying tissues should not be too heavily irradiated and the dose rate at greater depths should decrease as rapidly as possible. This type of treatment requires some compromise between the standard "deep" and "contact" techniques. It is called middle distance superficial therapy. The authors describe simple, short distance, small field applicators which they have had made for this purpose which they attach to their 200 kv. therapy tubes. With these tubes the most satisfactory focus-skin distance is 22.5 cm. or 26 cm. when applied to the Metropolitan Vickers continuously evacuated tubes. They give tables and graphs showing the radiation output, quality and depth dose measurements with this type of treatment. Modifications of the middle distance applicators to be used in the treatment of intraoral cancers are described and illustrated.—*Audrey G. Morgan.*

#### MISCELLANEOUS

WALKER, STELLA F. Classification and filing in department of roentgenology: standard nomenclature. *Radiology*, June, 1943, 40, 603. If each hospital adopts its own classification

it is apt to grow and become confused and fail to develop logically. The author therefore suggests the adoption by hospitals of the Standard Nomenclature of Disease which has developed under careful direction since 1928 and has recently been taken over by the American Medical Association which plans constant revision and periodic publication. It would seem comparatively simple to issue a small pamphlet of terms approved by the Radiological Society for use in connection with the Standard Nomenclature. All refinements of the classification need not be used in every hospital but the use of a uniform classification by different hospitals has obvious advantages.—*Audrey G. Morgan.*

BARNARD, VIRGIL L. A new surgical table top and cassette holder for surgical roentgenographic examinations of the hip. *Radiology*, June, 1943, 40, 599-602.

One of the hardest tasks in roentgenography is to get a true lateral projection of the head and neck of the femur. A surgical table top and cassette holder designed to accomplish this purpose are described and illustrated. Both anteroposterior and lateral projections of the head and neck of the femur can be obtained without flexing the thigh or moving the patient. There is no danger of contaminating the surgical field.

The table top is made of flawless plywood covered with formica which is a plastic similar to bakelite. It fits the top of the table and its thickness is such as to place the head and neck of the femur for the lateral projection approximately in the center of a 10×12 inch film. An angle of 127° with its apex toward the patient's head is cut in each side of the table top. The cassette is placed in the angle, with its edge resting on the edge of the table.

It is crowded into the patient's side between the iliac crest and the lower ribs, and held in place by a nurse. The tube is quickly placed in position and the exposure made. There is a sliding tray under the table in which the film for the anterolateral projection may be placed and slid under the patient.—*Audrey G. Morgan.*

LASNITZKI, ILSE. The effect of x rays on cells cultivated in vitro. Part II. Recovery factor. *Brit. J. Radiol.*, Feb., 1943, 16, 61-67.

Cultures were made of material from the choroid and sclerotic of chick embryos nine to eleven days old, subcultures being made every forty-eight hours. They were irradiated with single exposures of 100 r and exposures of 100 r

separated by intervals of forty-eight and ninety-six hours, single exposures of 1,000 r and exposures of 1,000 r separated by an interval of ten days. Tables and graphs are given showing the details of the results. The qualitative effects were the same in all cases; the differences were only in degree. There was always a temporary decrease of mitosis followed by recovery. There was a small wave of abnormal mitosis following the fall and a second wave, accompanied by the appearance of degenerate cells, after the recovery. With the dose of 100 r, mitosis never disappeared completely and the ratio of the mitotic phases, prophase, metaphase and telophase, was much less distorted than after the dose of 1,000 r. With the latter dose mitosis, both normal and abnormal, disappears for a short time and with the return of mitosis prophase is in excess of metaphase for some hours. Degenerate cells occur during the period when the ratio between the mitotic phases is disturbed. The first effect of radiation is obviously to disturb mitosis and upset the normal process of division in some of the cells that are undergoing mitosis at the time of irradiation. These cells form the first wave of abnormal mitosis and the number varies with the size of the dose.

Recovery is shown by the reappearance of normal mitosis, the restoration of the normal ratio between the phases and the disappearance of abnormal and degenerate cells. This occurred forty-eight hours after a dose of 100 r and ten days after a dose of 1,000 r. If a second dose the same as the first was given as soon as the cells showed apparent recovery, the effect of the second dose was greater than that of the first. If the interval between the doses was prolonged the quantitative effects of the first and second doses approximated each other.—*Audrey G. Morgan.*

MEDICAL RESEARCH COUNCIL. Medical uses of radium. *Brit. J. Radiol.*, 1943, 16, 54-58.

This is a summary of reports from experimental research centers for 1941. The Radiotherapeutic Research Unit at Hammersmith Hospital, London, reports continued work on the 2 million volt generator being constructed there. Experiments have been carried out on the electrical resistance of various bakelite-graphite mixtures with a view to correlating the electrical properties with composition. A new optical-mechanical method of working out a three-dimensional dosage system is being experimented with.

At the Royal Cancer Hospital, London, experimental work has been carried out, using a dose finder, on the spatial distribution of radiation around groups of radium needles and other sources. The technique of manufacturing large numbers of condenser ionization chambers bath of high and low sensitivity, has been developed. A wax sectional model of the human body has been constructed in such a way that measurements of dose within it can be made at a large number of points. Integral doses can easily be estimated from the results. With the condenser chambers and the model, information has been obtained in regard to the true energy absorption per unit surface dose over a wide range of qualities of radiation.

The Strangeways Research Laboratory at Cambridge has made a quantitative histological analysis of human biopsy material. The histopathology of irradiated sarcomas in the dog has also been studied as well as the histogenesis of skin tumors induced by benzpyrene in mice. Studies have been made of the mechanism of chemical carcinogenesis, the effect of irradiation on growth and differentiation *in vitro*, the effect of irradiation on the size of nuclei and the inactivation of animal viruses by irradiation.

A number of new experimental methods have been developed at the Department of Medicine, University of Cambridge, dealing largely with ultraviolet radiation.

The Mount Vernon Hospital, Northwood, reports on the biological effect of ionizing radiations, a technique for administering known doses of alpha radiation and the production of various injuries and inhibition of mitosis in bean roots by alpha radiation. Cell degeneration following relatively large doses of roentgen or radium radiation has been found to be due to the breakdown of cells in the delayed mitosis following irradiation.

The Barnato Joel Laboratories of the Middlesex Hospital, London, report on experiments showing the biological effects of radon irradiation of rabbits' ovaries.—*Audrey G. Morgan.*

HAWLEY SYDNEY J. Increased filtration for diagnostic purposes. *Radiology*, April, 1943, 40, 387-390.

It is customary in roentgenographic work to make a roentgenogram of high contrast by using low voltage and little or no filtration. While this gives a brilliant roentgenogram it may sacrifice the sharpness of outline necessary for diagnostic purposes. The relative densities

of many parts of the body are similar and disease may cause little change in density. Therefore, the increased sharpness of outline produced by increasing the filtration, say from 1 to 3 mm. aluminum, with a corresponding increase in voltage or exposure time, makes better diagnosis possible by producing increased sharpness of shadows and increasing the range of values that can be obtained. Roentgenograms are given illustrating the difference in roentgenograms taken by the usual method and with increased filtration.

The authors claim no originality for the method. The idea was suggested by Allen and Calder in the *British Journal of Radiology* and they present it to call it to the attention of American readers.—*Audrey G. Morgan.*

ATLEE, Z. J., and TROUT, E. D. A study of roentgen-ray distribution at 60-140 Kv.P. *Radiology*, April, 1943, 40, 375-386.

Study of the distribution of radiation around the roentgen tube is particularly important in superficial therapy where large fields are used at a short focal distance. The authors studied the effect of several factors on distribution at a range of voltage from 60-140 kv. (peak) with most of the work carried on at 100 kv. (peak). A tube current of 5 ma. was used in all measurements. A Victoreen condenser r-meter was used and all measurements made at the same focal chamber distance. The chamber was first centered directly below the focal spot. The intensity at this point was taken as 100 per cent and is referred to as the "central beam." The intensity at other points was plotted in percentages of this central beam. At 60 and 100 kv. (peak) studies of filtered radiation were made using 2 mm. aluminum. At 140 kv. (peak) the filtered studies were made with a filtration of 0.25 mm. copper and 1.0 mm. aluminum.

Graphs are given showing the details of the results with different types of tubes. Many of the methods used in superficial therapy were established around the Universal type Coolidge tube. So distribution around this type of tube was studied before that around the more modern types such as the oil-immersed superficial and medium therapy tube and the 20 target oil-immersed roentgenographic type tube. Experimental types were also constructed and studied including a 30 target oil-immersed tube, a 45 target oil-immersed tube, a curved target oil-immersed tube and a convex target

oil-immersed tube. The convex target tube gave the best results in treatment. The tubes used for treatment should not be used for roentgenography because of the changes in the pattern of field intensity due to roughening of the target. The target angle of a tube used for superficial therapy should be at least  $30^\circ$ . Field distribution can be improved by using a curved or even a convex target face for a tube that is used only for superficial therapy.—*Audrey G. Morgan.*

SYMPOSIUM. Protection against radiations in medical and industrial practice. *Brit. J. Radiol.*, Jan., 1943, 16, 1-7.

After the induction of Prof. Mayneord as President of the British Institute of Radiology and the Industrial Radiology Group of the Institute of Physics he introduced the subject of protection against radiation and said that the normal, healthy human being can tolerate without injury about one international roentgen per week of roentgen or gamma rays. This rate is sometimes known as the tolerance rate and quoted as  $10^{-5}$  r/sec. He also called attention to the growing use of radiation in industry and the necessity of protective measures there. He then introduced Ralston Paterson who spoke on the Effects of Radiation on Workers and S. Russ who discussed Accepted Standards in Radiological Protection.

Paterson described the early skin changes in radium workers. They appear in the form of erythema and glossiness of the skin, most marked around the nails. This comes from the handling of radium or radon. Warts may appear on the backs of the hands and undergo cancerous degeneration, though this usually occurs as a result of a single exposure to a large dose rather than to long-continued slight over-exposure. If exposure is continued the results may be fatal.

The effects on the blood of general exposure are manifested first on the white, rather than the red cells. There is an absolute and progressive leukopenia, the decrease being in the neutrophils. Some individuals who are particularly radiosensitive show an absolute lymphocytosis with absolute neutropenia as the first sign of over-exposure. White cell counts should be made at least monthly, but a monthly count on individuals for an adequate period would require considerable time. Taking the average white cell count of a group of workers is sug-

gested. If the average count of a group of 10 workers registers below 5,000 it proves that the working conditions are unsatisfactory.

Workers in medical radiology had to pay by bitter experience for their early lack of knowledge of the effects of the rays. Industrial workers should be protected by the knowledge acquired and rules for protection should be enforced by law.

Russ, speaking on accepted standards in radiological protection, called attention to the fact that it has been found that many young people engaged in radium luminizing show a lymphocytosis. It is questionable whether this is due to radon in the circulation or to gamma radiation from the radium which the workers handle. It would be useful to know whether the effect is caused by alpha or gamma radiation as the protective measures would be different in the two cases. Tests have been made in the last six months on the radon content of the expired air of workers. Generally radium workshops and luminizing rooms have a radon content of  $10^{-11}$  curie per liter. People who work in such rooms show radon in the expired air which may be due to living in a radon atmosphere or to actual ingestion of radium. If it is due to radon alone a positive test on Friday will have become negative by Monday but if there is radium in the body it is still positive. It is believed the working atmosphere should not be above  $10^{-10}$  curie per liter. It is harder to fix a safety figure for radium. Even normal human tissues contain some radium. If after a week-end test a person who has been handling radium for a long time shows a radon content in the expired air of  $10^{-11}$  curie per liter it is almost certain that some radium has been ingested and the work should be discontinued.

If these figures survive critical discussion he hopes they may be incorporated in the sixth edition of the recommendations of the Radium Protection Committee which is forthcoming.—*Audrey G. Morgan.*

BINKS, W. Protection in industrial radiology. *Brit. J. Radiol.*, Feb., 1943, 16, 49-53.

The current recommendations of the British X-Ray and Radium Protection Committee say that roentgen-ray workers can stand about 1 international roentgen of either kind of radiation in a week. They should not be exposed to more than that in industry any more than in medicine. Workers with the roentgen-ray apparatus

used for crystal analysis sometimes expose themselves to the direct beam for a short time without resultant severe injuries to the fingers. It should be possible to avoid such injuries by putting up a guard plate to protect the hands. The manufacturers of roentgen tubes try to produce self-protected tubes by intercepting the unwanted direct radiation by surrounding the tube as completely as possible with protective material of adequate lead equivalent. Graphs and tables are given showing roentgen-ray outputs for different voltages, the transmission through lead of roentgen rays excited at different voltages from 50 to 200 kv., and the thickness of lead required to reduce the direct roentgen-ray beam to the dose which can be tolerated without injury.

To protect the worker from scattered radiation he should be stationed behind a protective wall with an adequate lead equivalent, not less than 2 mm. for voltages up to 200 kv., or should stand in a lead-protected pulpit. The operator should stand as far as possible from the roentgen tube or radium source and persons not engaged directly in roentgen or radium work should not be allowed to enter the danger zone.—*Audrey G. Morgan.*

SPIERS, F. W. Materials for depth dose measurement. *Brit. J. Radiol.*, March, 1943, 16, 90-97.

The factors that determine the suitability of different materials for depth dose measurement are electron density and the effective atomic number. These were determined for a number of materials including rice, sugar, borax, sodium bicarbonate, boric acid, powder mixtures and waxes and pressdwoods. Graphs and the mathematical formulae used in the determinations are given. Water was found to be the most satisfactory medium for depth dose determinations in spite of the difficulty of using a liquid medium. Its electron density and atomic weight are practically the same as those of the soft tissues. Neither pressdwoods or waxes seem to be safe for use at wave lengths greater than 0.2 Å, particularly in low voltage therapy. If any material is to be used for the measurement of depth doses it should be compared with some standard, such as water, before using.—*Audrey G. Morgan.*

REINHARD, M. C., and GOLTZ, H. L. Quality, area, and distance relationship for  $D_5$ ,  $D_{10}$ , and  $D_{15}$ . I. *Radiology*, March, 1943, 40, 283-292.

Up to 1940 the New York State Institute for the Study of Malignant Diseases had worked with voltages not higher than 200,000 but at that time a million volt and a 400,000 volt roentgen generator were added. Knowledge of the depth measurements for these generators was limited. The authors therefore decided to assemble all the depth measurements made at this Institute for a number of years, together with the published results of other authors, in order to establish a relationship between depth intensity and size of field, quality and distance, so that depth intensities for one set of these conditions could be converted simply to another set. Ratio curves for distances of 5, 10 and 15 cm. from the surface are reproduced, providing a means for establishing depth intensity curves for any set of conditions used in roentgen treatment with from 200 to 1,000 kv. A depth dose table is given covering a range in quality from 0.9 to 9.0 mm. copper half-value layer, areas from 25 to 400 sq. cm. and distances from 50 to 100 cm.—*Audrey G. Morgan.*

REINHARD, M. C., and GOLTZ, H. L. Quality, area, and distance relationship for  $D_5$ ,  $D_{10}$ , and  $D_{15}$ . II. *Radiology*, March, 1943, 40, 293-296.

In a preceding article the authors gave tables and curves showing the relationship between depth intensities and the three factors of quality of radiation, size of field and focal skin distance at depths of 5, 10 and 15 cm. from the surface. They demonstrated a method of transposing a known depth dose from one set of these conditions to any other within the range 0.9 to 9.0 mm. copper half-value layer, 25 to 400 sq. cm. area treated, and 50 to 100 cm. focal skin distance. This paper presents an extension of this work. The depth was extended to 20 cm. and tables and curves are given from which it is possible to calculate depth doses within the range of 2 to 12 mm. aluminum half-value layers, 20 to 200 sq. cm. area and 20 to 60 cm. distance.—*Audrey G. Morgan.*





# THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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# THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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## PATHOLOGY OF THE ANOMALIES FOUND IN KNEE JOINTS

By MAJOR SAMUEL HAROLD NICKERSON  
*Medical Corps, Army of the United States*

THE patella has been a controversial subject of study by students of anatomy and embryology, and has figured prominently in many discussions concerning phylogenetic development and significance in the light of comparative anatomy. It has been abnegated by one school of writers as a structure which is slowly erasing itself as an essential integral part of the human skeletal framework and as a bone which impairs the performance of the quadriceps extensor apparatus. As a matter of clinical fact, some rather convincing findings have been presented to substantiate this quasi-condemnation of the patella. There is the other school of rather vehement proponents for the patella. They insist that not only is it essential, but that without it, the lower extremity loses its optimum muscular and mechanical efficiency. The truth must lie somewhere in between.

On closer inspection of the apparently conflicting data submitted by both sides, it seems quite clear that the opinions expressed concern two entirely different phases of the development of the patella; that is, the embryological phase of development as compared with the postnatal and functional phase. Walmsley,<sup>41</sup> Carey,<sup>9</sup> Bruce and Walmsley,<sup>6</sup> Haines,<sup>18</sup> de Vriese,<sup>39</sup>

and Langer<sup>25</sup> have written excellent and thorough papers concerning various phenomena of the developing patella. There appears to be no doubt that in the embryological development of this bone, the cells which are destined to become the early patellar nucleus are definitely embedded in the substance of the developing quadriceps muscle mass and that the embryonic circumstances of these two structures make their relationship a very close one. Carey,<sup>9</sup> in an excellent paper, studied this problem from a standpoint which he terms "the dynamics of histogenesis." Concerning the specific case of the hind limb bud, he concluded that all embryonic growth is against "resistances" of varying degree, due to a differential rate of growth of the skeletal tissues as compared with the premuscle mesenchymal mass. This causes a stretching of the cytoplasmic fibrils of this mass in the direction of femoral growth. The inception of muscle differentiation is then observed, while at the same time, the femoral rod undergoes compressile and tensile stresses due to resistances to longitudinal growth by the acetabulum, proximally, and the knee structures, distally. Since the femur is flexed on the tibia at about 90°, the patellar tissue comes into direct relationship with the lower end of the femur,

and also undergoes tensile stress from the developing muscle mass, and compressile force from the distal end of the femur. Carey<sup>9</sup> postulates that joint formation will occur in those places where centers of growth oppose each other. A condensation of nuclei, followed by a zone of liquefaction, eventually gives rise to the future joint space. Some contend that the compression lines of condensation of nuclei are due to heredity alone. Carey states that it is purely a mechanical result of opposed growth of contiguous centers. Be that as it may, it is amply shown that a strong interdependence between the patella and its tensile mass of developing quadriceps does exist. As a corollary, one can state that this interdependence is so exact that the slightest alteration in the developing premuscle mesenchymal mass would reflect itself in a commensurate alteration in both the configuration and size of the developing patellar nucleus.

Walmsley<sup>11</sup> studied the problem of quadriceps and patellar interrelationship from the purely anatomical viewpoint. He showed excellent illustrations of the early development of the embryonic patella, and was able to demonstrate an aggregation of rounded cells—forerunner of the patellar nucleus—in the substance of the quadriceps tendon in the 23.4 mm. embryo. This aggregation within the quadriceps network of cells is the earliest yet demonstrated in any embryo. It serves to impress upon one's mind the fact that should anomalous development occur, its inception may very well take place at a much earlier stage than has previously been suspected. The further differentiation of the patellofemoral articular cartilages, the formation of the synovial cavity, the primary appearance of the menisci and the development of crucial ligaments and capsule have all been described quite thoroughly by Langer,<sup>22</sup> and need not be recapitulated here.

It is significant that the early formation of the synovial cavity appears first on the medial side and progresses more rapidly on that side; similarly, the development of the

patellofemoral joint space is completed earlier on the medial aspect. After the primitive joint plate has disappeared in the medial patellofemoral space and the synovial cavity has progressively enlarged on that side, the lateral portion of the joint plate remains fused for a comparatively long time before it, too, undergoes the same processes. This developmental priority of the medial side is significant in that its structures might be interpreted as being of more ancient phylogenetic derivation. If so, it might very well facilitate the proper understanding of various abnormal patterns of development which are encountered in the case of the knee joint. This predominance of the medial joint components, including the femoral supracondylar area, is seen in the embryological development of the ox, and other ungulates, in general. It is only in the supracondylar femoral portion, on the lateral side, where the human fetus exhibits a greater anteroposterior measurement. This is essentially a primary human characteristic, predestined for function in the erect position of weight bearing, with the knee in complete extension. It would appear, therefore, that the lateral portions or components of the knee joint exhibit comparatively recent developmental characteristics. In the gorilla, both the femoral condyles are of similar size. It is only in the human that the lateral condyle exhibits a greater anteroposterior prominence.

Since the patella develops in relation to the femoral condyles and passes through a stage of fusion with them, the medial and lateral areas of its articular surfaces are at first approximately equal in size. A change in the relative size begins after the patella has become freed from the femur. It occurs slowly, but at the 192 mm. stage the articular surface of the patella is then divided by a vertical ridge into a larger lateral, and smaller medial area, which are relatively comparable in size to those of the adult. This change in the articular surface allows the patella to conform to the supracondylar surface of the femur (Walmsley).

De Vriese<sup>39</sup> carried out extensive measurements of the patella in various species of animals, as well as various races of the human species, and came to the conclusion that this bone was undergoing phylogenetic regression; that it was not a sesamoid bone but a true bone which, like the fibula, owes its presence in the skeleton to phylogenetic necessity, but that in postnatal life, its conformity in size and shape are entirely dictated by function alone. Walmsley's description of the formation of the primitive patellofemoral articular disc, or joint plate, and its further formation of the patellofemoral joint space, closely follows the same processes of any diarthrodial joint formation. This would appear to lend further anatomical proof to the osseous authenticity of the patella as postulated by de Vriese, who finally concludes that the patella is a typical bone which is on the road to increasing reduction.

Some very interesting experiments were carried out by Niven,<sup>27</sup> whose paper will be discussed in greater detail below. The developing mesenchyme of nine day old avian patellae *was divided into equal portions before chondrification could be microscopically detected*. Tissue culture studies were made and two small discrete masses of cartilage appeared. That portion which was medial to the line of division was always smaller in size than the lateral portion which consistently grew larger. Other than this observation, Niven made no comment, but it would appear to be another indication of the developmental trend of the patella. In further confirmation of this conception of the knee joint, the work of Langer is classical. He describes the independent formation of the medial and lateral portions of the fetal synovial cavity with the medial portion preceding the lateral. He also describes the independent formation of two joint spaces, separated by a septum, extending in the median plane, from the posterior surface of the patella through the entire knee joint, above and below the patella. He then describes the gradual fusion of the two joint spaces. He finally pos-

tulates that should the fusion be incomplete, the median septum might persist even to the point of two residual synovial joint spaces.

It is believed that it would be well to recapitulate what has been stated so far:

1. The close anatomical relationship between the patella and quadriceps muscle mass has been demonstrated (Walmsley and others).

2. The important dynamic interdependence of the developing patella and quadriceps muscle has been clearly shown experimentally (Carey).

3. The priority of development of the medial components of the knee joint has been embryologically substantiated (Langer; Walmsley).

4. The patellar mesenchymal cell mass, if divided and cultured *in vitro*, will show a smaller medial area of chondrification and a larger lateral area of similar chondrification, during their independent, though self-limited, period of tissue culture growth (Niven).

5. The prominence of the lateral femoral supracondylar area in the human fetus, as a human characteristic, is demonstrated.

6. The embryonic patella develops a larger lateral and smaller medial articular surface.

7. The entire patella is undergoing a slow and gradual development erasure (de Vriese).

Certain thoughts become crystallized in the reader's mind. The uppermost is that the knee joint is undergoing alterations in all its components. This change is dictated by the fact that only the human who walks in the erect posture also maintains his knees in full extension and is exhibiting itself as a hypoplasia or aplasia in the medial joint structures and as an accessory growth in the lateral aspect of the patella and knee joint.

Thus far, an attempt has been made to illustrate the mutual relationship and strong interdependence between the patella and the quadriceps muscle. The work of Niven, in her successful attempt to culture

individual avian patellae in proper isolation from the remainder of the embryonic limb, would at first glance appear to refute all this. However, Niven was only successful in experiments with the nine day old embryos. The seven to eight day old embryos did not yield similar results. In none of the cultures did articular surfaces develop, and in all of them, the life of the culture was abbreviated, and areas of necrosis began to appear. The reason for the success in the cultures from the nine day old embryos can be attributed to the fact that only at that late date had cell differentiation progressed far enough to permit a period of independent cellular differentiation into cartilage to take place in the culture. Furthermore, this growth was only possible through the impetus of its own cellular activity which finally expended itself, due to lack of the proper environmental stimulus. It does not prove the complete independence of the patella, during differential growth.

#### CASE REPORT

CASE 1. This is the case of a young man, aged twenty-four, who presented himself with complaints of pain related to both knee joints. These complaints had been present "all his life," and had troubled him in one manner or

another. He definitely remembers that at the age of about thirteen his knees felt weak and gave way whenever he played strenuous games such as football. His "knee caps would slide sideways" on occasions. The remainder of his personal history is negative. He recalls that his mother once "hurt" her knee, and since then she has had trouble somewhat similar to his, but in the left knee only. Prompted by a justifiable curiosity, he made a comparison of his knees with other members of the family, composed of one brother and two sisters. Their knees were normal as far as he could determine. However, he did establish the fact that his sister's child, aged thirteen, had "split" thumb nails; also his brother, aged thirty, had similar "split" thumb nails. He stated that his thumb nails have never grown, so that they never needed a manicure. Similarly, the nails on both fifth toes exhibited the same condition.

*Examination.* The patient was first examined completely unclothed. His posture, state of nutrition, musculature, and general condition were satisfactory. There was no apparent deformity, other than that to be described about the knees. In the sitting position, and viewed from one side, one immediately noticed the absence of the usual patellar prominence. The range of motion in the knee joints was smooth, complete, and painless; no effusion was present; there was no ligamentous relaxation about the knee joints; the quadriceps apparatus was somewhat lax, so that the patella could be pushed laterally as far as the anterior prominence of the lateral femoral condyle, but could not be pushed laterally farther than this. The musculature of the quadriceps was closely examined and the absence of a major portion of the lower third of the vastus medialis was observed. Instead, there remained a rather broad, flat, sheath-like aponeurotic structure which, together with the overlying skin, was the only thickness which lay between the examiner's finger and the subjacent synovial lining.

The patella was found to be exceptionally small and situated well in the lateral half of the knee joint area. The missing portion of the patella corresponded roughly to that area of the bone which normally would have provided tendinous anchorage for the vastus medialis. The latter was also missing to a large extent.

The thumb nails were found to be thin and almost transparent. Other than this, nothing of note could be found.

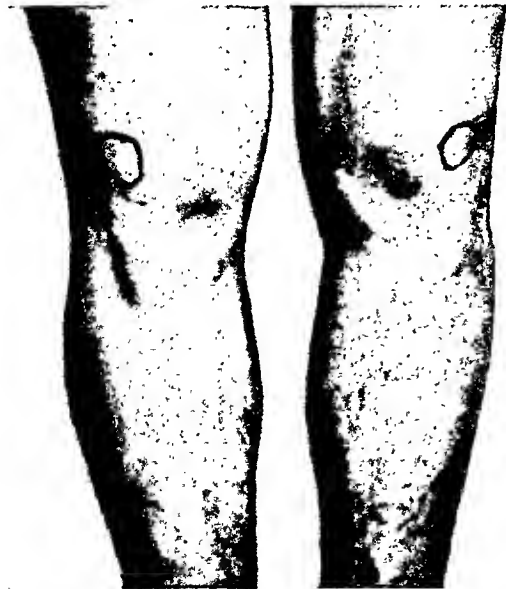


FIG. 1. Case 1.





FIG. 2. Case 1. *A* and *B*, the level below which the vastus internus is almost absent bilaterally. Note the flattening due to the absence of the patellar prominence. This renders the tibial tubercle rather prominent in comparison.

*Roentgen Findings.* Various joints and long bones were examined roentgenologically. The wrists exhibited an apparent fusion between the os magnum and the articulating metacarpal bone, bilaterally. On the right wrist, one found a small ossicle on the dorsum of the hand, overlying the carpal lunate and triquetral bones, and apparently articulating with them very much like the pisiform articulates with the triquetral bone on the palmar surface.

Detailed roentgenograms and pneumarthrograms were made of both knee joints. These yielded some rather interesting findings.

In the anteroposterior view, one can clearly visualize the synovial cavity in both knees. The medial compartment is seen to be smaller and underdeveloped compared with the lateral (Fig. 4, *A-B*). There is also visualized a vertical septum which separates these two unequal compartments. It extends downward and is seen to end in the infrapatellar fat pad, in the intercondylar area.

In the lateral view, clearer detail of this septation is possible. It is incomplete, and allows intercommunication between the two compartments. The edge of this septum is falciform, and faces toward the center of the joint space. In one of the lateral views, its posterior end anchors itself to a small projection just anterior to the anterior tibial spine. This projec-

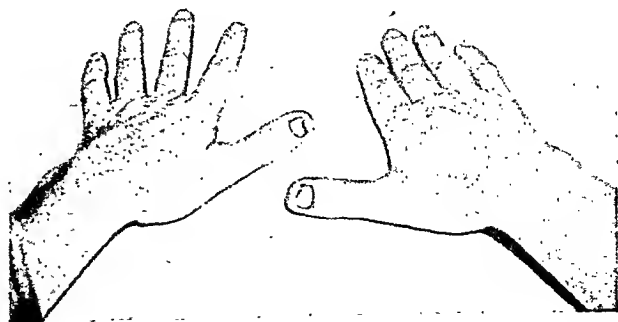


FIG. 3. Case 1. The thumb nails have been slightly retouched to better delineate their outlines.

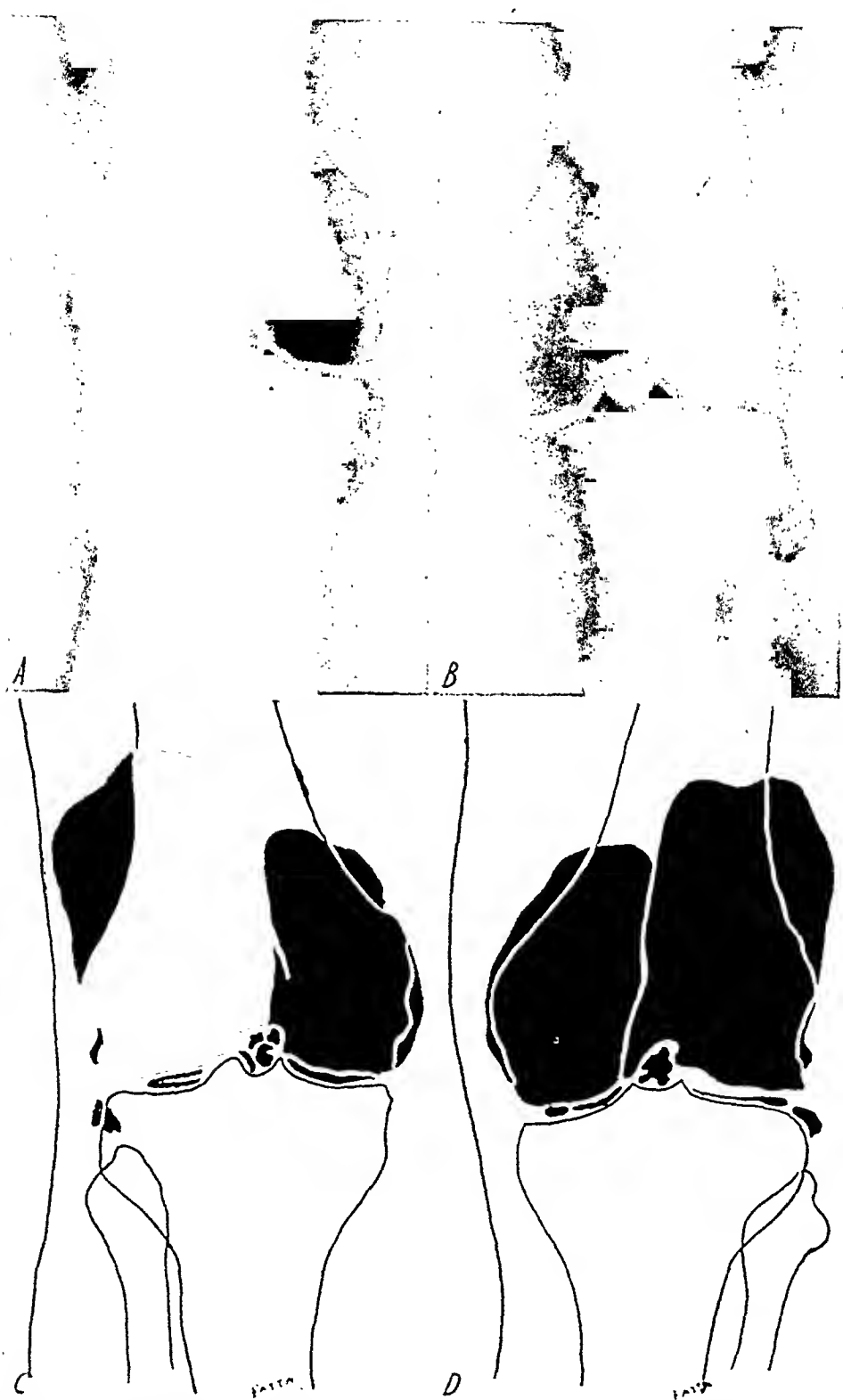
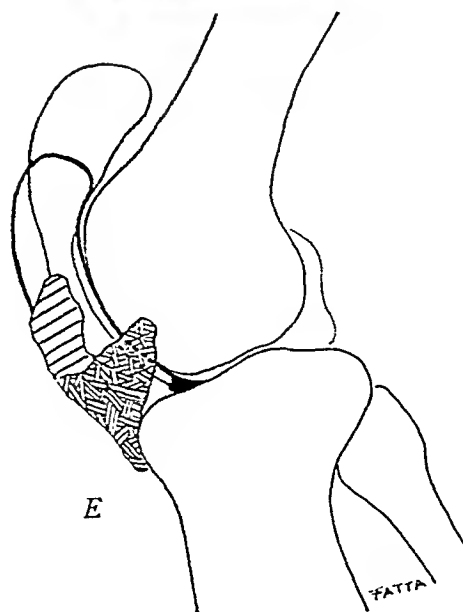


FIG. 4. A-D. Case 1. Pneumarthrograms and drawings of pneumarthrograms of the knees. Note the smaller underdeveloped medial synovial compartment. Note also the vertical septation which extends downward toward the intercondyloid notch. The septation is complete in the anteroposterior view. It is seen to be incomplete in the lateral view. Vertical septation with intercommunication between the compartments of the knee joint is not uncommonly seen in the horse.



FIG. 5, A-E. Case 1. Lateral views of the pneumarthrogram, outlining the boundaries of the incomplete septation. Note how the latter finds attachment posteriorly to a projection just anterior to the anterior tibial spine. This projection is not visualized without air as a contrast medium. Therefore it is non-osseous in character. Note also that the infrapatellar fat pad, which is the remnant of the embryonic median septum, is within normal limits of shape and size.



tion was not visualized without air as a contrast medium, and therefore must be of a non-osseous nature, probably cartilage or fibrous tissue (Fig. 5, *D-E*).

It was necessary to deflate the knees to allow sufficient flexion in order to obtain satisfactory vertical views (Fig. 8, *A-F*). It is amazing how much soft tissue detail can be brought out by

Langer<sup>23</sup> has already mentioned the possibility of the persistence of median septation in the knee joint. However, no instance has been found in the literature resembling the findings reported above.

Vertical septation in the knee joint, with intercommunication between the com-

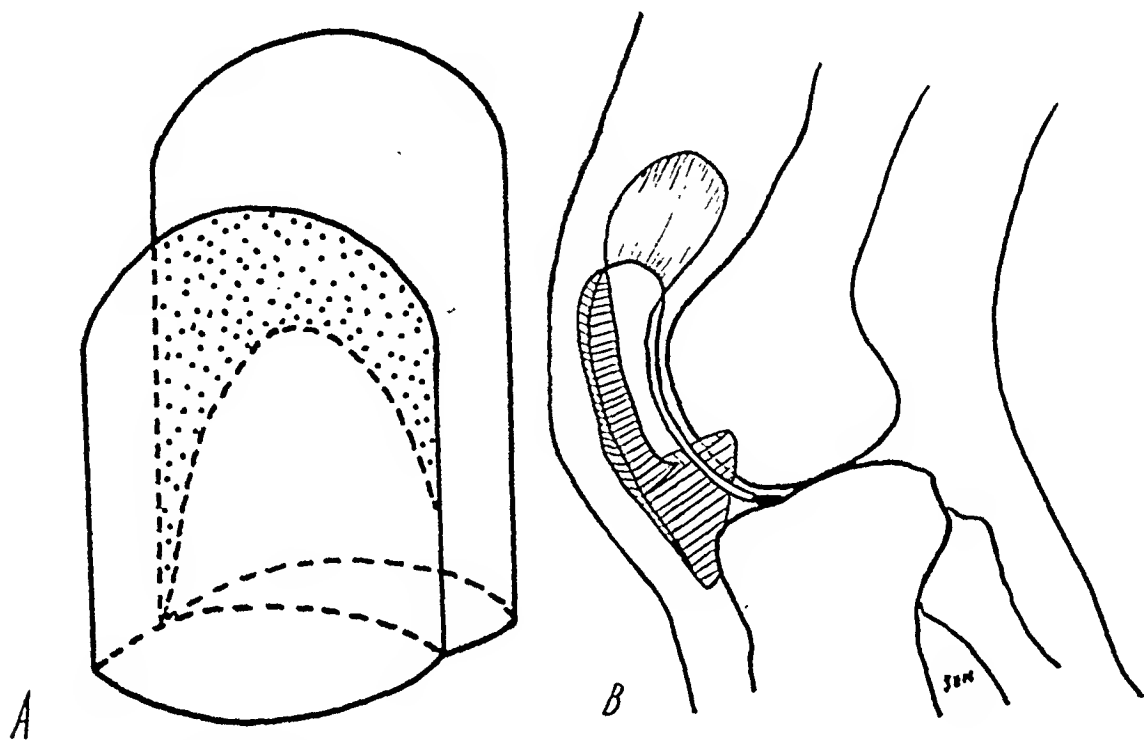


FIG. 6*A*. Diagrammatic illustration of the intercommunication between the smaller medial and larger lateral compartments of the synovial cavity through an incomplete partition or septum. The defect in the septum is bordered by a rather sharp curved falciform edge.

FIG. 6*B*. This drawing represents a reconstruction of the appearance of the vertical septation. Anteriorly, close to the mid-level of the patella, it is roughly triangular in shape. It then sweeps upward over the anterior wall, rapidly tapering off, so that as it reaches the spaces between the domes of the two compartments, it is but a mere edge. It then separates the two compartments by a broad fan-like septum. As it reaches the posterior wall, it again tapers considerably and finally becomes attached to a projection of non-osseous architecture just anterior to the anterior tibial spine. The septum always presents a falciform edge facing towards the interior of the knee joint.

this technique. Medial to the osseous patella, and in an identical position, could be found a soft tissue structure which closely resembles the bony patella in size and outline. If one were to draw a line about these two structures, the result would be the outline of a practically normal patella. The pneumarthrograms seem to indicate that the medial portion of the patella never went into differentiation from the rounded cell state (during the 23.4-30 mm. stage) and matured into ordinary fibrous tissue, but retained its outline and size to a great extent.

partments, is not uncommonly found in the horse.

A search has been made of the literature for descriptions of this particular anomaly or rather, combination of anomalies, and it was found to be not uncommon. In none of the papers, however, was a description of the thigh musculature given, except in one case by Susman,<sup>25</sup> who mentioned "the obvious wasting of the thigh muscles." An opportunity for a study of the interior of

the anomalous knee joints by the use of air injected into the synovial cavity has presented itself—the so-called pneumarthrogram.

Genealogical studies were made by Aschner,<sup>2</sup> Turner,<sup>38</sup> Malkin,<sup>26</sup> and Susman.<sup>35</sup>

changes in addition. These families are found in the United States, France, Austria, and Australia.

Rubin,<sup>29</sup> Spellisy,<sup>34</sup> and Cadilhac<sup>8</sup> reported a number of cases with completely absent patellae. Cadilhac's painstaking re-

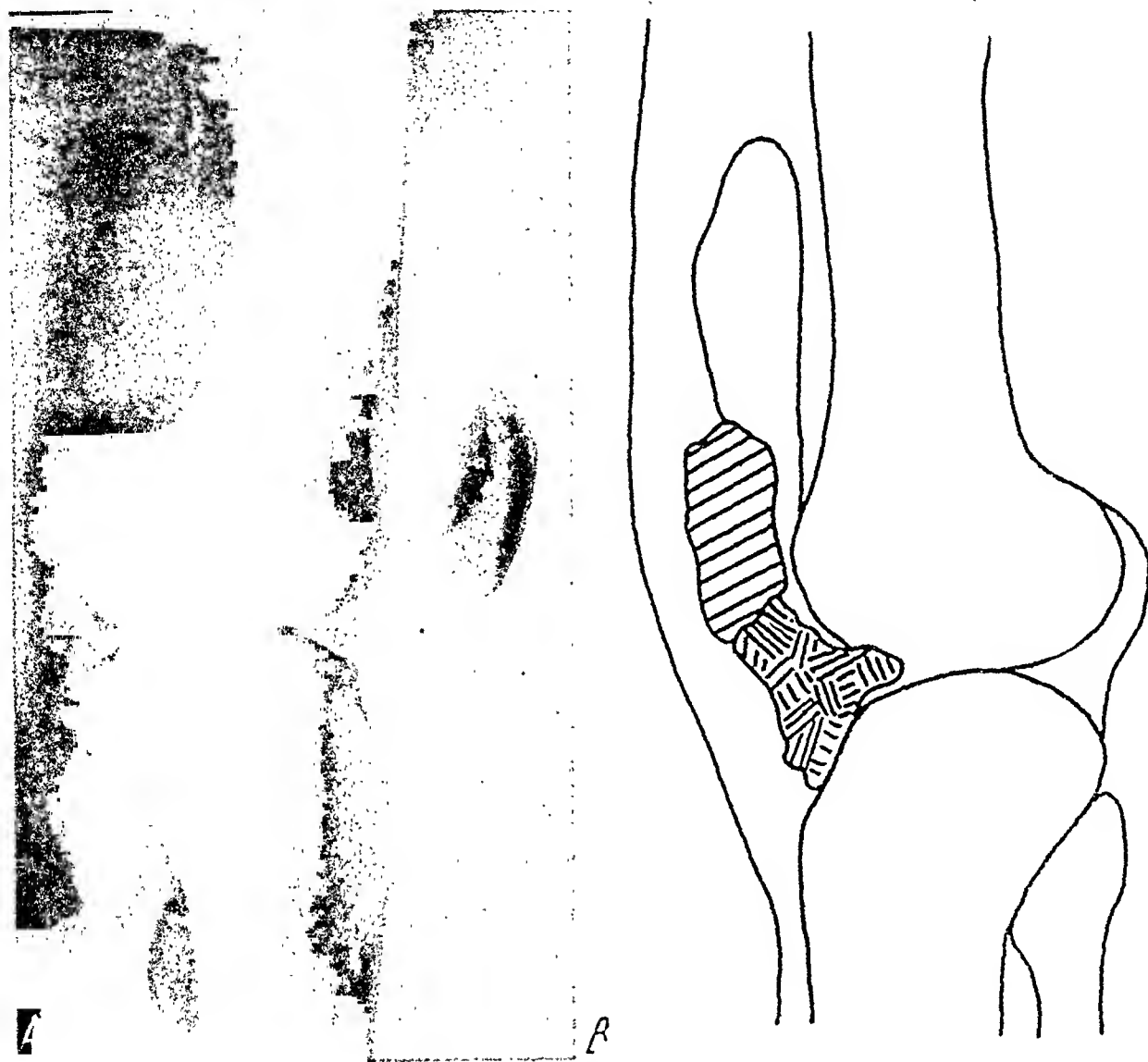


FIG. 7, *A* and *B*. Lateral view and drawing of the normal pneumarthrogram. Note the outline of the synovial cavity and suprapatellar pouch. Note also the size and shape of the infrapatellar fat pad.

Their case histories appear to establish the fact that the anomalies were transmitted by the affected female member of the family in the vast majority of cases. In Susman's series, it appears to have been transmitted only by the maternal parent. However, the affected female does not always transmit it to her offspring. Many members of these families exhibited fingernail

port of over 80 cases is a classic of detail and bibliographical research. His compilation included all the reported cases which he could find in the literature up to the date of his thesis (1907). In his clinical descriptions, however, many of the cases exhibited other congenital anomalies about the knee joint, as well as dislocation and deformity in the ankle or hip joints. An-

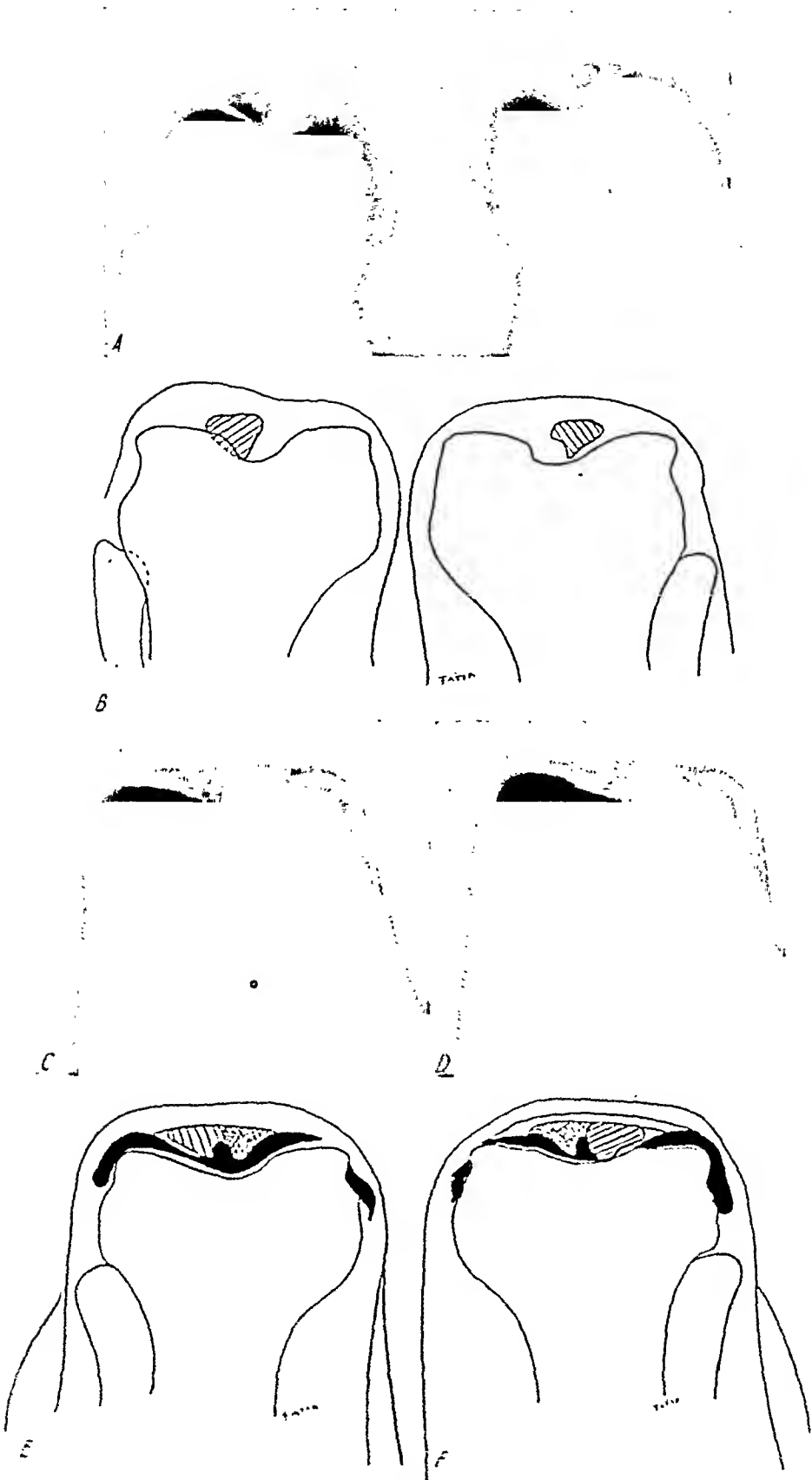


FIG. 5. A-F. See opposite page for legend



other large group of his cases exhibited hyperextension deformity, or genu recurvatum. The only illustration found in Cadilhac's paper shows a congenital dislocation of the knee with the femur displaced posteriorly, producing a marked genu recurvatum. I do not feel that these should be included in this report as additional examples, similar to the described case, since all Cadilhac's cases were complicated by various additional deformities of a congenital nature. He pointed out that in 16 of his cases the absent patella eventually appeared and could be felt. In his conclusions, he stated that in the vast majority of the cases he noted anomalies of the quadriceps extensor apparatus, the commonest of which was atrophy and absence of muscle tissue. Many of them exhibited faulty insertion of the patellar tendon.

The greatest contribution from his work lies in the fact that once again the close patelloquadriceps relationship is exhibited. As Berkheiser<sup>3</sup> stated "... in the human being born with genu recurvatum, the patella fails to develop until the deformity is corrected surgically and natural functional stresses are restored, after which the patella enlarges and develops. ..."

The question that arises in the study of the pathology in the case described here is whether we are dealing with a patella, or whether it represents an accessory bone center with the patella proper entirely absent. The question is well justified and the answer is not simple. A glance at Figure 9 will show the result of a composite drawing of many tracings of the patella in its usual positional migrations or variations within normal limits. Superimposed on this, one can see the composite drawing of many similar tracings made of accessory centers

in the bi-, tri-, and multi-partite patellae which were found in the department of roentgenology. For purposes of discussion, we will designate the composite normal patellar tracing as the patellar area. Simi-

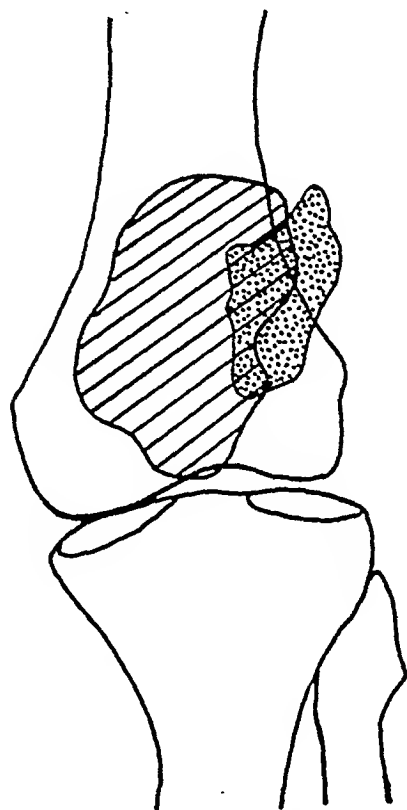


FIG. 9. In this drawing, the stippled area represents the composite variation in positions of accessory patellar centers—the so-called accessory patellar area. It indicates that this area is generally in the upper and outer portion of the patellar area.

larly, we will designate an accessory patellar area. The relationship of the latter to the former is constant. The accessory patellar area will always be found in the upper and lateral aspect of the patellar area. The same type of tracings were made in order to establish a relationship between the patellar area and the patella in our case described here. The result is seen in Figure 10.

FIG. 8, *A* and *B*. Vertical views and drawings to illustrate the close relationship of the patella to the lateral femoral condyles. It rests well within the intercondyloid space.

FIG. 8, *C-F*. It was necessary to partially deflate the knees in order to obtain sufficient flexion for the vertical views. The mass of undifferentiated tissue medial to the patella is clearly outlined. Its shape and size is similar to that of the osseous portion. If one were to draw an imaginary line to encompass both of these structures, the outline would be surprisingly close to that of a normal patella. Compare this with Figure 8, *A* and *B*, where the soft tissue was not visualized without air as a contrast medium.

It seems quite evident that the positional relationship is definitely in the lower and lateral aspect of the patellar area. Furthermore, the smaller area is almost entirely included in the patellar area. Tracings made in the lateral, as well as the vertical planes, tend to further confirm what is now quite evident. Therefore, we can, with a good deal of assurance, assume that the struc-

tics of histogenesis, in the pig embryo, the feeling persists that we are not dealing with a complete, small, hypoplastic patella. It is in reality a case of full development of the lateral portion of the bone associated with no development of the medial portion—a hemiplasia, as it were, if one may coin a word to describe the situation. It can further be postulated that the ab-

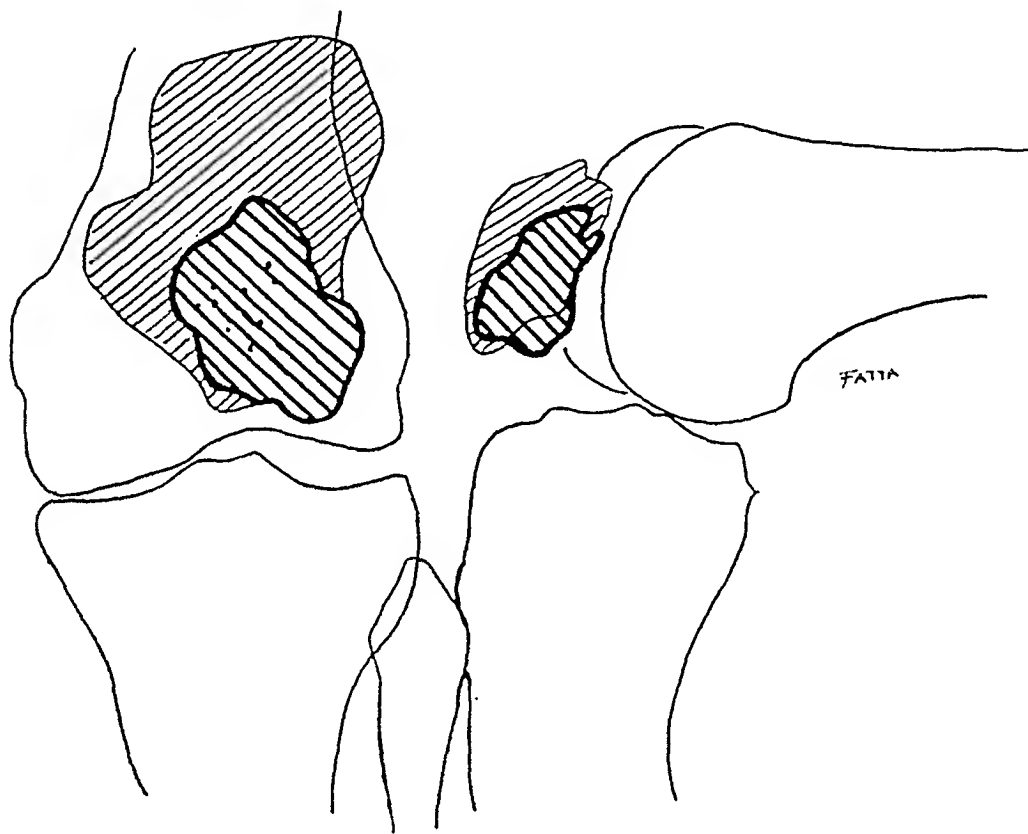


FIG. 10. Composite drawing of a large number of positional variations of the normal patella. Over this, in both the anteroposterior and lateral views, was superimposed a composite drawing of the relative position of the anomalous patella in relation to each individual normal tracing. It falls almost entirely into the true patellar area in both views. This would tend to reinforce the impression that we are dealing with a true patella, and not with an accessory center as illustrated in Figure 9.

ture seen in Figure 5, *A* and *B*, is true patellar bone.

The partial absence of the vastus internus should be interpreted as being a significant feature. A strong impression prevails that the "wasting of muscle," mentioned by Susman, probably represents a situation which obtained in many of the cases which were reported in the past, but were not given sufficient clinical prominence. Stimulated by Carey's work on the

sence of development in a portion of the patella can be directly traced to the absence of a portion of the quadriceps muscle group, resulting in a proportionate loss of tensile stress on the developing condensation of precartilaginous patellar round cells, in the embryo. This loss of tensile influence on a portion of the embryonic patellar nucleus actuated an arrest of differential growth in an equivalent area of precartilaginous patella. In its lateral portion, the

embryonic cells developed in the usual manner. In the medial portion, on the other hand, the same embryonic cells were "short-circuited" into mature fibrous tissue formation. This produced a fibrous tissue mass which has retained its outline to a great extent; to what extent, can be determined by the pneumarthrograms described in Figure 8, *A-E*. It would be interesting to know at what stage in fetal development the above arrest occurred.

To quote Walmsley,<sup>41</sup> "The patella is seen to be developed in relation to the lower surface and the lower part of the anterior surface of the femur, and though there is no direct contact of the patella and femur, the lower part of the patellar surface of the femur has taken form already in the 23.4 mm. embryo."

Since the femoral condyles are already well formed in the 23.4 mm. embryo, and early beginning transformation of the patellar cells into embryonic cartilage does not occur before the 30 mm. stage, it is assumed that the defects as noted in our case were laid down in the abnormal anlage, or failed to differentiate somewhere in this segment of the developmental circle (that is, 23.4–30 mm.). This conception is also enhanced by the fact that during this stage muscle differentiation progresses. Therefore, the primary cause for the lack of development of the quadriceps, with which the patella is closely bound in its embryonic life, is due to the lack of differentiation of the premuscle mass from its rounded cell stage. Later, in the 32–55 mm. embryo, the joint plate of the patellofemoral joint is seen and the beginning synovial cavity formation is also seen in the 35 mm. embryo. It is not difficult to understand why the formation of the suprapatellar pouch, as well as the synovial cavities (particularly the medial cavity), should be directly influenced by the developmental change just described.

The patellar nucleus develops in the muscle mass; the quadriceps pouch enlarges by extension into this same mesenchymal mass; and the formation of both

these joint structures predicates the presence of a normal muscle mass. If the latter is deficient, it necessarily follows that the patella and synovial cavity will also be deficient. It is therefore evident that from the 30 mm. stage onward, the future development of the fetal knee joint (such as in the case of our patient) was already predestined to come to an anomalous end, due to

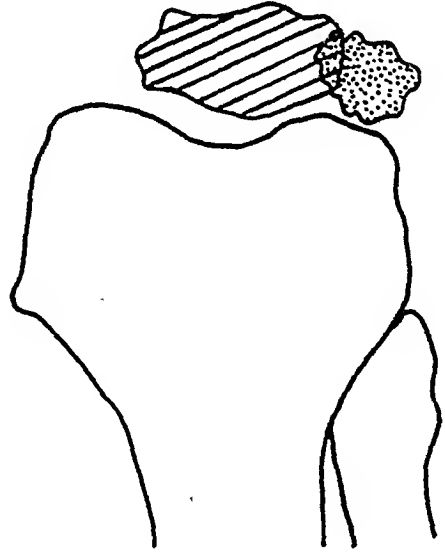


FIG. 11. A composite drawing of a number of tracings in the vertical view, of bi-, tri-, and multi-partite patellae. The stippled area represents the accessory patellar area. The striped area represents the patellar area. The relationship between the two areas is seen. A glance at Figure 8*B* shows that the patella would fall entirely into the true patellar area.

abnormal factors at work, at that early stage.

It becomes apparent that all the roads of investigation and inquiry converge upon the structure which is most pertinent to the problem—the premuscle mesenchymal mass, which is undergoing differentiation into early quadriceps formation. No sooner have we focused our attention upon this structure, than we ask ourselves the next question: Why does this mesenchymal mass fail to differentiate? The answer to this lies bound in the interpretation of that multifarious phenomenon called heredity.

A short consideration of the hereditary factor would not be amiss, and would help to clarify some obscure points. To one who

is not acquainted with the profound secrets locked up in the gene, all this is confusing. After a careful study of some of the literature on this subject, several elementary and well known points seem to stand out boldly above the others. Aschner<sup>2</sup> predicated that the combination of ectodermal (fingernail) and mesodermal (knee joint) abnormalities in the individual described in our case report were due to separate pathologic factors in the genotype. The genotype represents the sum of all potential hereditary factors present in the fertilized ovum. Where do these potential anomalies reside in the fertilized ovum? They are to be found in the genes, which are in turn but portions of the chromosomes. These genes within the same chromosome may be juxtaposed or may be situated at opposite poles of the chromosome. In this manner, they become "linked genes" and may go on, in close association, to development of characteristics, normal or abnormal. Thus, with two closely linked genes, the association of mesodermal and ectodermal anomalies may occur in the same individual. For practical purposes of this study, the anomalies in the case described above were initiated by aberrant or abnormal linked genes, which brought about an aberrant embryological development of the premuscle mesenchymal mass of the quadriceps extensor apparatus. This deprived a portion of the developing patella of the necessary growth stimulus for differentiation. In a general way, the original stimulus for differentiation in embryonic cells is imparted by the fertilized ovum. The capacity for growth differentiation in these cells is actuated by those factors which are inherent in any living cell, but this capacity is necessarily self limited and will entirely cease unless the developmental stimulus is perpetuated by a series of embryonic events which serve to maintain the smooth continuity of this cell differentiation. Each so-called embryonic event gives rise to its successive event with a resultant corresponding change in both the anatomical (Walmsley) and dynamic (Carey) environment, and so on to final completion

of the organism. Any interruption in the chain of successive events will produce a concomitant interruption in cell differentiation. If it occurs early, a complete lack of differentiation (aplasia) will occur. If it occurs later, varying degrees of partial differentiation, or hypoplasia, will be found.

#### SUMMARY

1. A case report of an individual with congenital changes in the knee joint has been presented.

2. The basic pathology has been described as being due to aberrant or pathological linked genes which possess abnormal mesodermal and ectodermal characteristics, respectively. This explained the presence of both ectodermal and mesodermal anomalies in the same individual.

3. The primary developmental aberration due to the pathological gene is manifested by faulty and incomplete differentiation of the premuscle mesenchymal mass which ordinarily is destined to become a portion of the quadriceps extensor apparatus—the vastus internus.

4. This lack of muscular differentiation has initiated a number of secondary developmental changes in the patella, quadriceps pouch and the synovial cavity. All these changes have occurred in the medial portion of the knee joint and have exhibited either hypoplastic or aplastic characteristics.

5. The presence of an incomplete vertical septation in the knee joints has been described and explanation for its presence has been given.

6. The feeling is expressed that the patella which has been described above represents its lateral portion only. An explanation for the absence of its medial portion has been given.

7. The medial portion of the knee joint possesses older phylogenetic structures than its lateral portion. Anomalies in the medial compartment will present themselves in the form of developmental erasure. Anomalies in the lateral portion will present themselves in the form of accessory

growth. It is to be noted that accessory patellar centers are constantly found in the lateral portion.

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## ADDENDUM

Since the completion of this paper, I have had the opportunity to examine another similar case.

CASE II. A man, aged twenty-six, came to the orthopedic clinic complaining of pain in the left elbow and both knees. On examination he was found to have unusually small patellae which were displaced laterally bilaterally. The

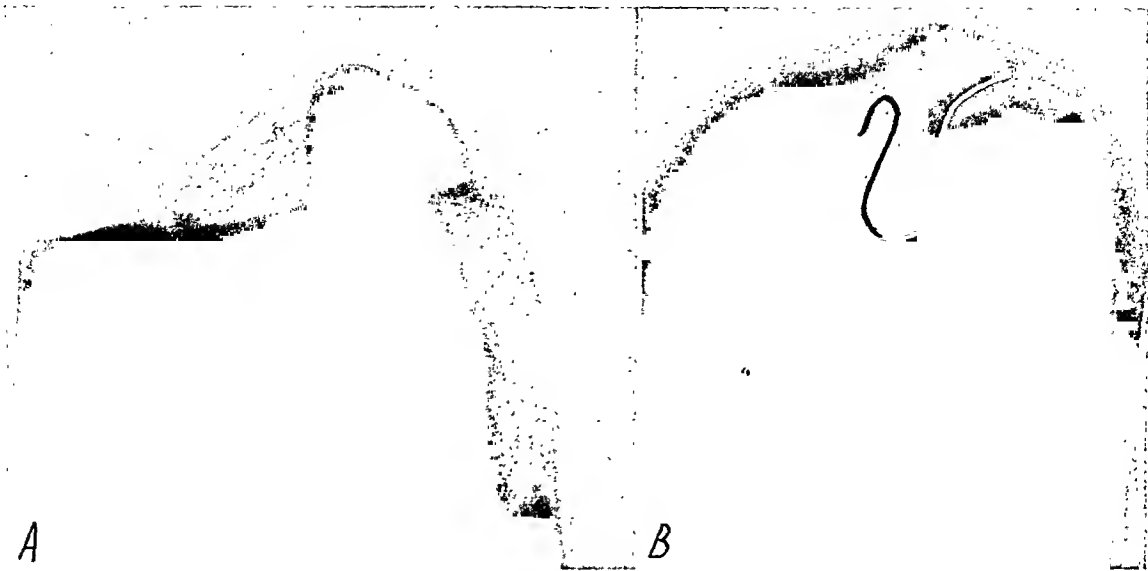


FIG. 12. Case 11. *A*, vertical pneumarthrogram of the right knee. Note the attenuation of the isthmus. The "body" is smaller on this side. *B*, vertical pneumarthrogram of the left knee. The "body" (slightly re-touched) is again seen, separated from the patella by its "isthmus."



FIG. 13. Case 11. Lateral views. The left patella (*B*) is at a distinctly lower level than on the right (*A*). Note that due to this difference in position the left patella reveals a trabecular system which contains an equal number of traction trabeculae and compression pillars. On the right side, the predominant system is that of many converging compression pillars.





FIG. 14. Case II. Lateral pneumarthrograms. The vertical septation is clearly defined. The infrapatellar fat pads are of normal size. The anteroposterior pneumarthrograms are not included because they were not clear enough for reproduction.

head of the left radius was found to be congenitally small and luxated.

An opportunity was also given to examine his son, aged four. Both patellae were absent. However, it is my feeling that the patellae will eventually appear in their lateral portions.

Figures 12, 13 and 14 show the later changes which might be expected to appear over a period of years. Had this individual been examined a score of years ago, I have a strong feeling that the findings would have been different. The faulty mechanics secondary to the lateral luxation tendency of the patellae have

resulted in further stretching and attenuation of the capsular tissues as well as the quadriceps apparatus.

In the left knee the patella lies at a distinctly lower level than in the right. The pneumarthrograms reveal that the isthmus of tissue between the undifferentiated "body" and developed patella has become longer, thinner, and attenuated, particularly in the right knee. The septation is again visualized in both the lateral and anteroposterior views. The smaller medial and larger lateral synovial compartments are seen as well.



# SPONDYLOLISTHESIS

## A COMMENTARY ON ETIOLOGY, AND AN IMPROVED METHOD OF ROENTGENOGRAPHIC MENSURATION AND DETECTION OF INSTABILITY

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### INTRODUCTION

**S**PONDYLOLISTHESIS may be defined as a forward displacement of a vertebral body secondary to a separated neural arch. The essential underlying predisposing factor is the bilateral defect in the pars interarticularis of the neural arch, which Neugebauer,<sup>6</sup> in 1892, called "spondylolysis or spondyloschisis interarticularis."

The diagnosis of spondylolisthesis depends primarily upon roentgenographic demonstration. However, the information obtained hitherto by the usual anteroposterior and lateral views has been deemed inadequate because:

(1) A method of diagnosis has not been clearly set out, and the roentgenologist has been confused with the terminology of prespondylolisthesis, and first, second, and third degree types.

(2) An accurate method of measuring the degree of spondylolisthesis has been lacking. It has been customary in the past to describe the displacement as a linear one. Actually, the vertebral body is displaced through a space, which usually does not lend itself to linear measurement.

(3) The degree of instability of the subluxated vertebral body has not been fully investigated. In some clinics, it has been routine in these cases to obtain an erect lateral roentgenogram (centered over the lumbosacral junction) to detect the effect of weight bearing upon the degree of instability of the subluxated vertebral body, by comparison of the erect with the recumbent roentgenogram. In some cases this is found to be inadequate, in that erect lateral roentgenograms in hyperextension and hyperflexion yield additional information regarding instability.

(4) It has not been generally appreciated

that the oblique projection, as described by Hubeny<sup>3</sup> in 1931, shows the defect in the pars interarticularis to excellent advantage.

(5) Spondylolisthesis has, in some quarters, been too glibly referred to as a "congenital anomaly." This aspect of the disease is of special interest to the Army, where it is important to know whether or not a soldier's disability is developed in the line of duty.

We have attempted to correct these deficiencies in our study of 41 cases of spondylolisthesis, among 1,131 lumbosacral spine examinations in an overseas general hospital. A scheme has been devised for the diagnosis and accurate mensuration of the degree of spondylolisthesis, and instability of the affected vertebral body. The oblique views have been almost routine in our lumbosacral spine examinations, and an incidence of over 5 per cent with defects in the pars interarticularis has been noted. The defect may be missed if this view is omitted.

### ETIOLOGY OF SPONDYLOLISTHESIS

Neugebauer's original concept was that the defect in the pars interarticularis was due to a lack of fusion of two centers of ossification, which were thought to exist to form each lateral one-half of the neural arch.

Mall<sup>4</sup> disproved this concept by newer methods, and his work has been further verified by others (Willis,<sup>8</sup> Chandler,<sup>1</sup> Hitchcock<sup>2</sup>).

Willis, however, contended that the defect in the pars interarticularis was due to a failure in ossification similar to that found in spina bifida. After studying the spines of 1,520 human skeletons, he diagrammatically showed seven positions where laminar

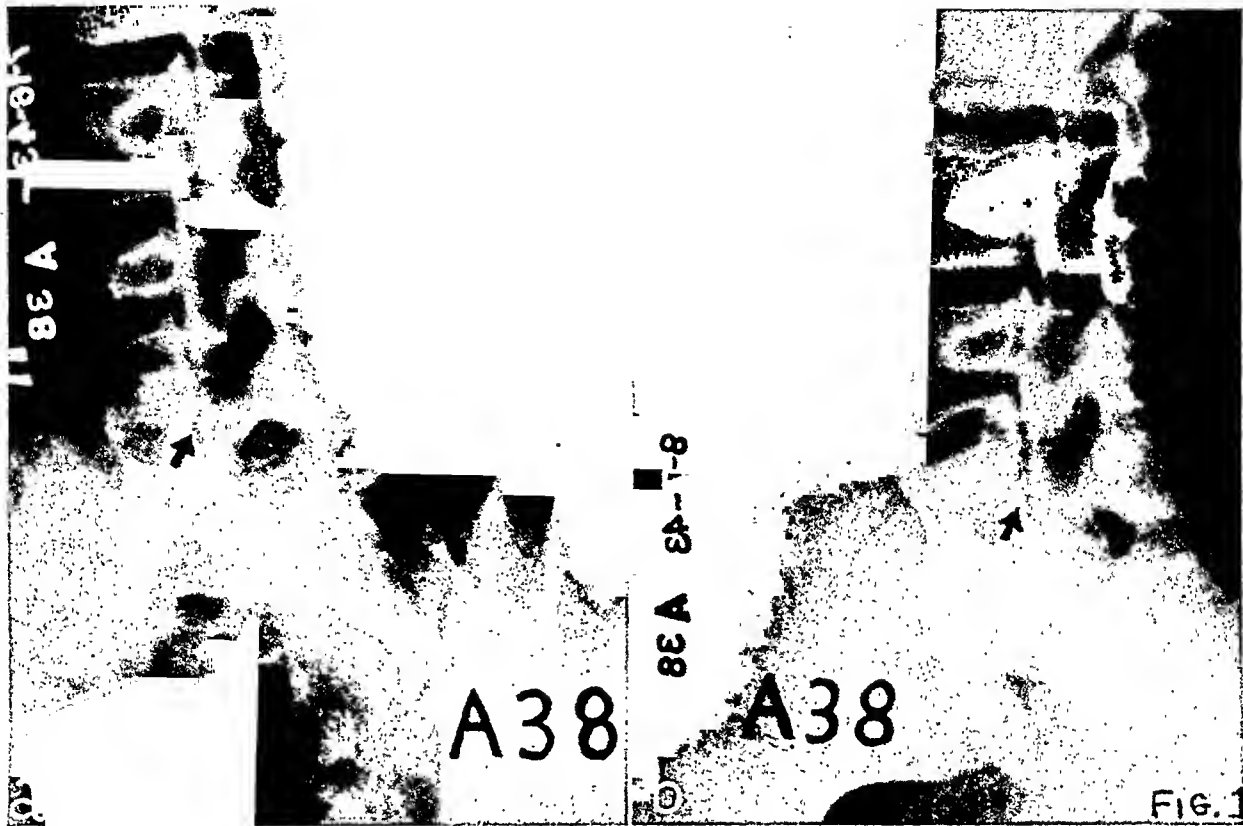


FIG. 1, *a* and *b*. Case A38. Selective action of trauma on the pars interarticularis. Value of the oblique view. Right oblique roentgenograms twenty-two days apart showing the bone resorption along the line of the defect in the pars interarticularis which occurred in this time interval. The first roentgenogram was taken one week after the patient (white male, aged twenty) fell on his back on maneuvers. The pain was very severe. Patient was treated by immobilization in a body cast for nine weeks and then discharged to duty.

separations may occur. None of these had the characteristics of fracture, such as signs of bone repair or resorption. He concluded that the actual displacement of the vertebral body was due to separation of these fibrocartilaginous areas as the result of acute or chronic trauma.

There are some who favor a completely traumatic origin for this disease. Chandler<sup>1</sup> and Hitchcock<sup>2</sup> noted that ossification of the pars interarticularis progressed by the formation of cyst-like spaces with a thin shell of bone. The pars interarticularis consists largely of cartilage and a large lake of blood vessels. Both of these authors thought this area to be particularly vulnerable to fracture. Hitchcock tested the strength of the neural arch in the lower lumbar region of newborn cadavers, and found the pars interarticularis to fracture very easily, even unilaterally. He argued that, since the defect is found at all ages,

the earliest being four years, the trauma probably occurred very early in life, such as during delivery or early in the post-natal period.

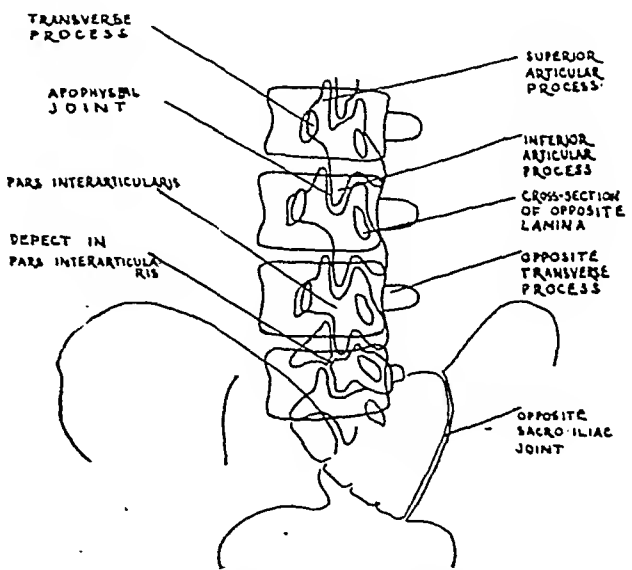


FIG. 2. Diagram of oblique view showing defect in the pars interarticularis.

The affect of trauma on the pars interarticularis was noted in one of our patients, in whom a unilateral defect in the isthmus was observed following an injury to his back. A definite increase in rarefaction of bone along the line of the defect became

A history of trauma associated with spondylolisthesis cannot always be elicited. Meyerding<sup>5</sup> reported 38 per cent (in 121 cases), and we found 43.9 per cent (in 41 cases) with a history of trauma before the onset of symptoms. The pars interarticu-

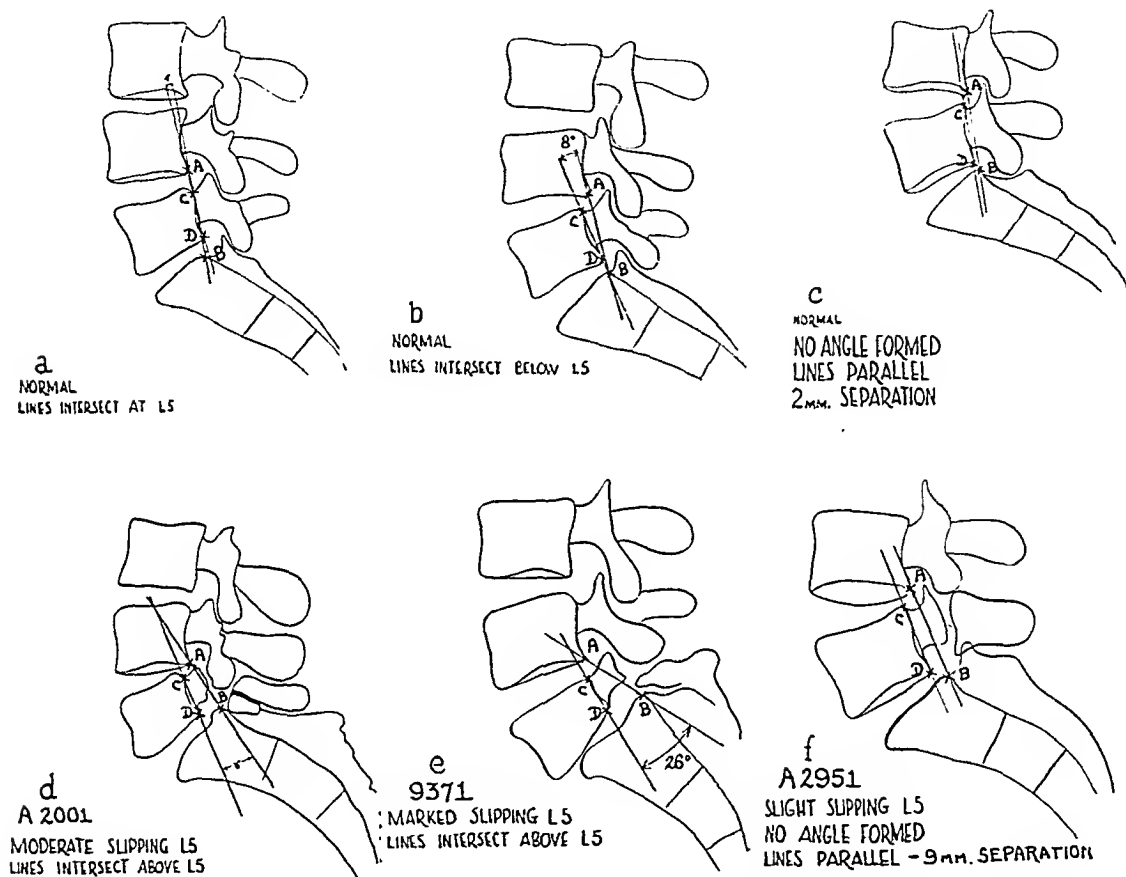


FIG. 3, *a*, *b* and *c*. Tracings of roentgenograms to show the three general types of normal lateral lumbosacral spines.

FIG. 3, *d*, *e* and *f*. Tracings to show the arrangement of the lines in cases of spondylolisthesis. The position of the apex of the angle is pathognomonic for spondylolisthesis. If the lines are parallel, in spondylolisthesis, they are separated 4 mm. or more. *d*, Case A2001. Weight bearing hyperextension. Moderate spondylolisthesis. No instability. *e*, Case 9371. Weight bearing neutral. Degree of instability between recumbent and above roentgenogram was 14°. Severe spondylolisthesis when patient stands. *f*, Case A2951. Slight spondylolisthesis, standing hyperextension. Degree of instability 6 mm. when patient's position changes from neutral standing to hyperextension.

apparent over a period of twenty-two days (Fig. 1 and 2). There is no way of knowing whether or not the defect was there prior to the trauma, or whether it represented a true fracture. Regardless of this, however, the above findings suggest that a selective action can be exerted by trauma on the pars interarticularis.

laris is a frail segment under considerable stress and even minor traumata could fracture this isthmus, the patient forgetting the incident completely if he were not incapacitated at the time. Fractures early in life would also be unknown to the patient.

*In summary*, whether or not the original defect is developmental or traumatic, there

is evidence that trauma, even of minor degrees, may widen the defect, initiate symptoms, and even start the displacement. Certainly, in the rigorous training of soldiers, with long hikes, carrying packs, lifting heavy weights, "rough-riding" in tanks, and the like, the development of spondylolisthesis is a definite possibility.

(2) Another line is drawn between the posterior upper and lower lips of the slipped vertebral body (points *C* and *D* in Fig. 3).

(3) The lines are extended, if they are not parallel, so that they meet and form a measurable angle. The position of the apex of this angle is characteristic for spondylolisthesis.

TABLE I  
GENERAL ANALYSIS OF CASES

	Cases	Per cent
1. Total number of lumbosacral spine examinations	1131	100.0
2. Analysis of lumbosacral anomalies		
a. Spina bifida	293	25.9
b. Sacralization of L-5	76	6.7
c. Lumbarization of S-1	42	3.7
d. Defect pars interarticularis	57	5.1
Total number of lumbosacral anomalies	468	41.4
3. Analysis of pars interarticularis defects (spondylolysis interarticularis)		
a. Without slipped vertebra (no spondylolisthesis)	16	28.0
1. Associated anomalies in vertebra with defect	4	
2. Associated anomalies in adjacent vertebra—not in vertebra with defect	2	
3. No associated anomalies	10	
b. With slipped vertebra (spondylolisthesis)	41	72.0
1. Associated anomalies in slipped vertebra	13	
2. Associated anomalies in adjacent vertebra, but none in slipped vertebra	7	
3. No associated anomalies	21	

The disease cannot be dismissed lightly as a congenital anomaly.

MENSURATION OF SPONDYLOLISTHESIS

The displacement of the vertebral body in spondylolisthesis is seldom linear, since usually the lower portion of the vertebral body is displaced more than the upper. In the mensuration of spondylolisthesis, provision must be made for space estimation. This is done by drawing lines on the lateral roentgenogram, centered over the lumbosacral junction, as follows (Fig. 3):

(1) A line is drawn between the posterior lower lip of the vertebral body above the one involved, to the posterior upper lip of the vertebral body below (points *A* and *B* in Fig. 3).

(4) The angle between these two lines is then measured with a protractor. If the lines are parallel (very seldom in spondylolisthesis), the linear distance between the lines is measured.

This method of measurement gives an accurate concept of the degree of spondylolisthesis. If it is desired, angles up to 10 degrees can be called slight, 11 to 20 degrees moderate, and greater than 20 degrees severe. When the lines are parallel a distance of more than 3 mm. is abnormal. It is always best, however, to record accurately the displacement by reporting "a spondylolisthesis with displacement through an angle of X degrees (or rarely, a distance of X mm.)." This method also furnishes a means of measuring accurately any change

TABLE II  
GENERAL ANALYSIS OF 41 CASES OF SPONDYLOLISTHESIS

1. Degrees of displacement (recumbent neutral position)				
	L-5	L-4	L-3	
A. Angular displacement				
1. 3°-10° (slight)	30	3	1	
2. 11°-20° (moderate)	4	0	0	
B. Linear displacement				
2 cases—4 mm.				
1 case—3 mm. in neutral position but unstable	<u>3</u>	<u>0</u>	<u>0</u>	
Total:	37(90.2%)	3(7.3%)	1(2.4%)	
2. Stability				
A. Unstable slipped vertebral body (4 with history of trauma)		7	17.0%	
1. Demonstrated by routine erect neutral film	4			
2. Requiring hyperextension for demonstration	3			
B. Stable slipped vertebral body (14 with history of trauma)		34	83.0%	
1. To all methods of examination	11			
2. To neutral weight-bearing study only	23			
C. Degrees of instability	Measurement of spondylolisthesis in:			
Case No.	Recumbent	Neutral Erect	Neutral Hyperextension	Maximum Degree of Change
A2079	3°	3°	6°	3
A3761	17	17	20	3
A2951	3 mm.	3 mm.	9 mm.	6 mm.
9371	12°	26°	Not done	14
76	9	12	Not done	3
9538	7	15	Not done	8
1274	9	12	Not done	3
3. Disposition of cases				
A. Transferred to United States		24 cases	58.5%	
B. Limited duty in this area		2	4.8%	
C. Transferred to another hospital in this area		1	2.4%	
D. Discharged to full duty		14	34.3%	
4. Total number of cases of spondylolisthesis with history of trauma				
		18	43.9%	
A. Unstable	4 cases			
B. Stable	14			

which occurs in weight bearing, flexion, and extension by comparison of the measured angle on each of these roentgenograms. A measurement of the degree of mobility of the vertebrae in these relative postures is to be preferred to superposition of tracings apart from its descriptive value, because the vertebrae are in different relative positions when flexed, and when extended, and cannot be superimposed.

The accuracy of this method of mensuration depends entirely upon the quality of

roentgenograms obtained. The posterior margins of the vertebrae and sacrum must be clearly identified for accurate estimation of small degrees of change. We have found the method probably to be accurate to within an angle of 2 degrees.

#### CASES STUDIED AND TABULAR RESULTS (See Tables I and IV)

There were a total of 1,131 lumbosacral spine examinations in twenty-two months in this overseas general hospital (April,



1942 to February, 1944). There were 57 cases with defects of the pars interarticularis; 41 with spondylolisthesis and 16 without.

All of the cases of spondylolysis interarticularis were studied with routine anteroposterior, oblique and lateral recumbent and erect neutral projections.

In addition, the last 18 cases of spondy-

3° to 10° displacement—slight

11° to 20° displacement—moderate

Greater than 20° displacement—severe

The fifth lumbar vertebral body was involved in 37 cases with the degree of displacement falling into the following groups:

Angular displacement, 34 (slight, 30; moderate, 4)

Linear displacement, 3

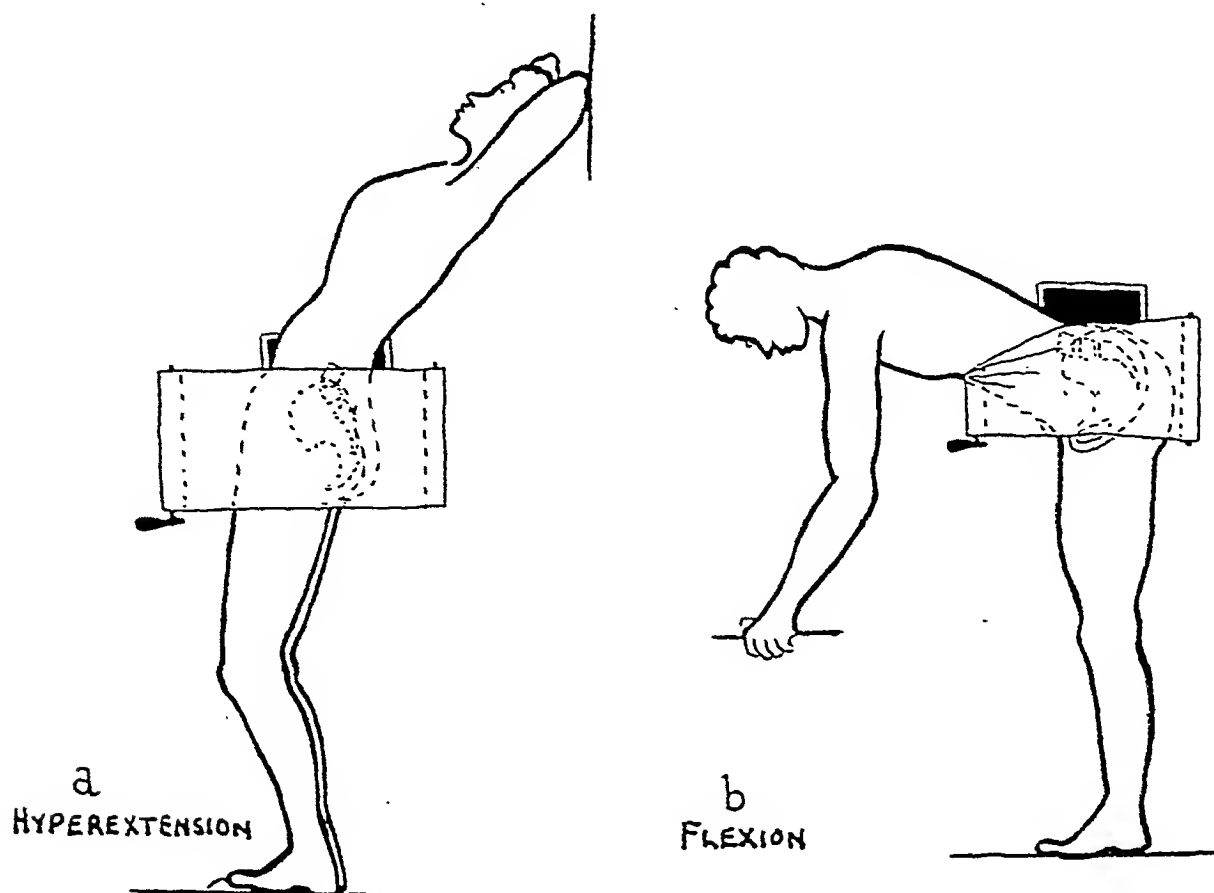


FIG. 4, *a* and *b*. Weight bearing flexion and hyperextension posturing diagram. Diagrams show method of posturing patient for standing lateral views of the lumbosacral spine in hyperextension and hyperflexion. (The degree of flexion is varied with the patient's tolerance.) The supports are merely used to steady the patient and not to diminish the weight-bearing function of the spine. The immobilization band is placed at pelvis level.

*Average Technique:* 30 ma., 78 kv. (peak), 36 inch target-to-film distance, 9 second exposure (small 2.0 mm. focal spot, par speed screens, long cylindrical cone 7.5 cm. in diameter, Potter-Bucky diaphragm).

lolisthesis and 15 normal patients were studied with additional erect lateral roentgenograms in hyperextension and hyperflexion, as shown in Figure 4.

Table II summarizes the pertinent findings among the cases of spondylolisthesis. The mensuration of the degree of spondylolisthesis can be arbitrarily divided into three categories:

The fourth lumbar vertebral body was involved in slight displacement in 3 cases.

The third lumbar vertebral body was displaced in 1 case through an angle of 8 degrees.

A total of 7 patients had demonstrable instability of the displaced vertebral body—4 of which could be demonstrated by a comparison of the routine weight-bearing

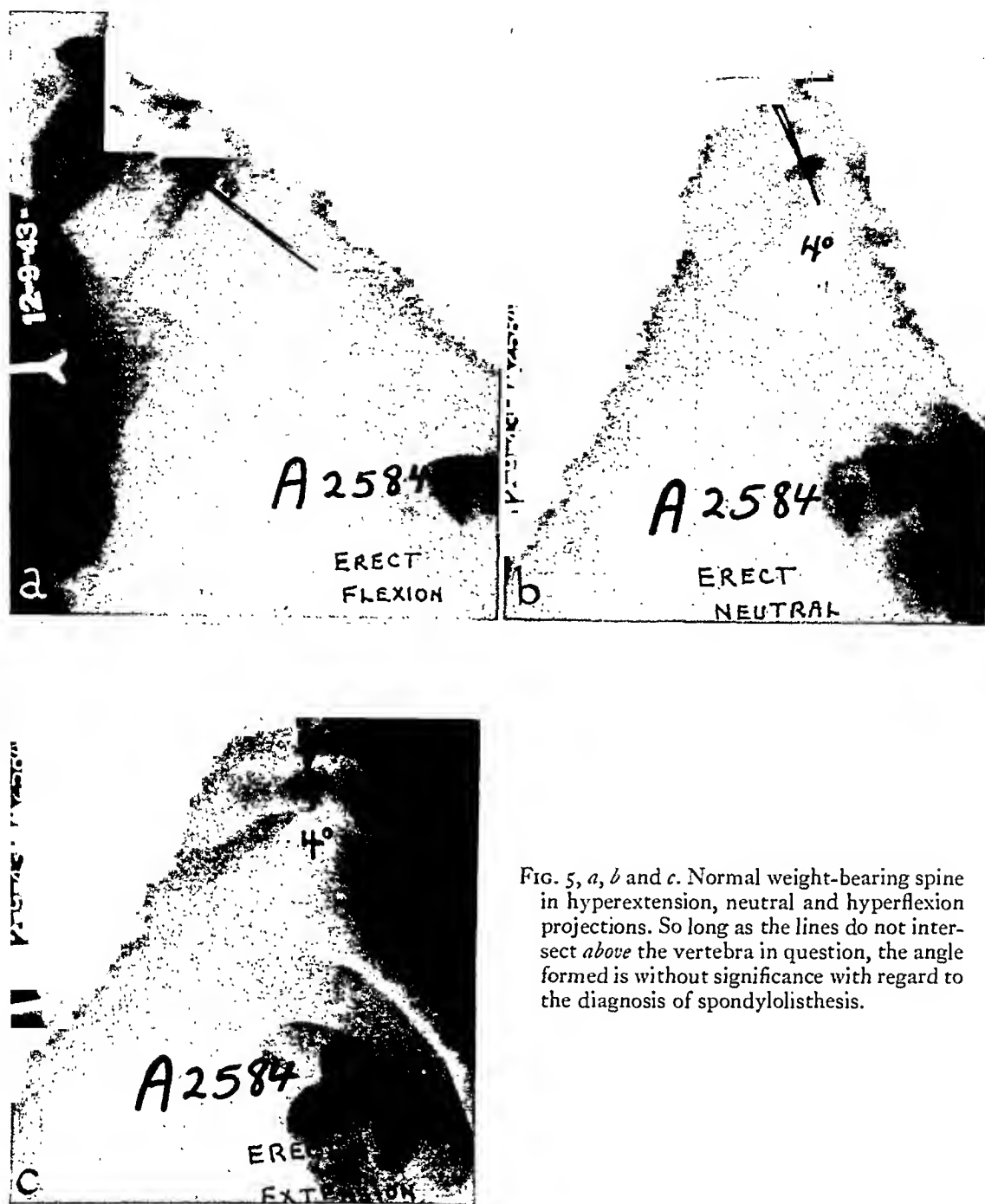


FIG. 5, *a*, *b* and *c*. Normal weight-bearing spine in hyperextension, neutral and hyperflexion projections. So long as the lines do not intersect *above* the vertebra in question, the angle formed is without significance with regard to the diagnosis of spondylolisthesis.

neutral lateral roentgenogram with the recumbent neutral view. The remaining 3 cases required the additional special views in flexion and extension. The maximum degree of instability in these 7 cases is shown in Table II. This varied from 3 to 14 degrees of angular displacement, and 6 mm. of linear displacement in 1 case.

A history of associated trauma prior to the onset of symptoms was obtained in 4

out of the 7 unstable cases (57 per cent), and 14 out of the 34 stable ones (41 per cent), or 43.9 per cent of the total number of cases of spondylolisthesis.

#### MENSURATION: NORMAL VS. SPONDYLOLISTHESIS

(On Lateral Views of Lumbosacral Spine)

A. General Remarks. The method of mensuration outlined previously on any

lateral lumbosacral roentgenogram gives a pathognomonic configuration of the lines in spondylolisthesis (Fig. 3, *d, e, f*).

In the normal, the lines always either intersect below or at the level of the fifth lumbar vertebra; or if they are parallel (Fig. 3, *a, b, d* and Fig. 5) to one another, they are never more than 3 mm. apart.

In spondylolisthesis, the two lines practically always intersect above the slipped vertebral body. Very rarely (3 cases out of the 41), they are parallel (Fig. 3*f*), but at a distance greater than 3 mm.

These differences hold true no matter what position the patient is in when the lateral roentgenograms are taken.

**B. *Weight Bearing Neutral vs. Recumbent Neutral.*** In the normal, the angle or relationship of the lines does not change significantly when the patient changes from the recumbent to a weight-bearing neutral position.

In spondylolisthesis (Fig. 6 and 7), the slipped vertebral body may or may not become displaced more with the added strain of weight bearing. Increased displacement with weight bearing is interpreted as indicating instability of the lumbar spine. Instability was thus demonstrated in 4 cases of spondylolisthesis (9.8 per cent). The angles of displacement increased from 3 to 14 degrees in these cases.

The lower surface of the unstable vertebral body usually moves more than the upper, in "rocking chair" fashion, with the upper posterior lip (point C) acting more or less as a pivot.

**C. *Standing Spine in Hyperflexion.*** In the normal flexed lumbar spine, the two lines usually approach one another and may even become superimposed (Fig. 5). This would indicate that the upper surface of the fifth lumbar vertebral body moves less than the lower, the opposite of that noted previously for the unstable vertebral body in spondylolisthesis.

In spondylolisthesis, when the spine as a whole is flexed, the arms of the angle usually remain in the same relative position to one another, as in the neutral position. A change greater than 1 or 2 degrees is

rarely observed, and it is difficult to be certain that this is outside the margin of error. This is evidence that the slipped vertebral body and adjacent vertebrae remain relatively fixed with respect to one another when the spine is flexed.

The standing film in hyperflexion will also usually demonstrate the defects of the pars interarticularis to better advantage than the routine neutral projection (Fig. 8).

**D. *Standing Spine in Hyperextension.*** Normally, when the spine is hyperextended, the lines usually remain in the same relative position to one another as in the neutral position.

With spondylolisthesis, hyperextension of the lumbar spine will occasionally demonstrate instability when the weight-bearing neutral roentgenogram fails to do so. Thus, in 2 cases, the angle of displacement increased by 3 degrees with this method, and in 1 case, by 6 mm. of linear movement, when the neutral weight-bearing roentgenogram failed to demonstrate instability (Fig. 9).

#### VALUE OF ROUTINE ROENTGENOGRAMS IN THE STUDY OF SPONDYLOLISTHESIS

**A. *Oblique Views.*** The right and left anteroposterior oblique views of the lumbar spine are taken by placing the patient in the recumbent position, and turning his right and left side up respectively, so that his back forms an angle of 35 to 45 degrees with the table. The degree of obliquity must be varied in some patients depending upon the degree of obliquity of the lumbar facets.

In interpreting these roentgenograms, it must be recalled that the facets nearest to the film are parallel to it, or horizontal, and hence are the facets shown to best advantage (Fig. 1, 2 and 8). Likewise, the apophyseal joints nearest the film are the ones clearly visualized; but because the plane of the sacroiliac joints is perpendicular to the plane of the apophyseal joints, it is the opposite sacroiliac joint which is clearly shown.

The importance of these views for the visualization of defects in the pars inter-

articularis has not been fully appreciated. This is especially true when the defect is unilateral, in which case the routine lateral view usually does not show the defect. In cases with bilateral defects in the pars interarticularis, these can usually be demonstrated in the straight lateral projection, as well as the oblique projections (Fig. 6, 7, 8 and 9). Occasionally, however, a bilateral defect could readily be overlooked if

special lateral views in hyperflexion were not obtained, as outlined previously, and if oblique views were also omitted (Fig. 8).

The defect in the pars interarticularis is seen in the oblique projection as a discontinuity with jagged saw-toothed margins. The line of dissolution may measure 1 or more millimeters. Usually, the upper tip of the superior articular process of the vertebra below points directly toward the de-

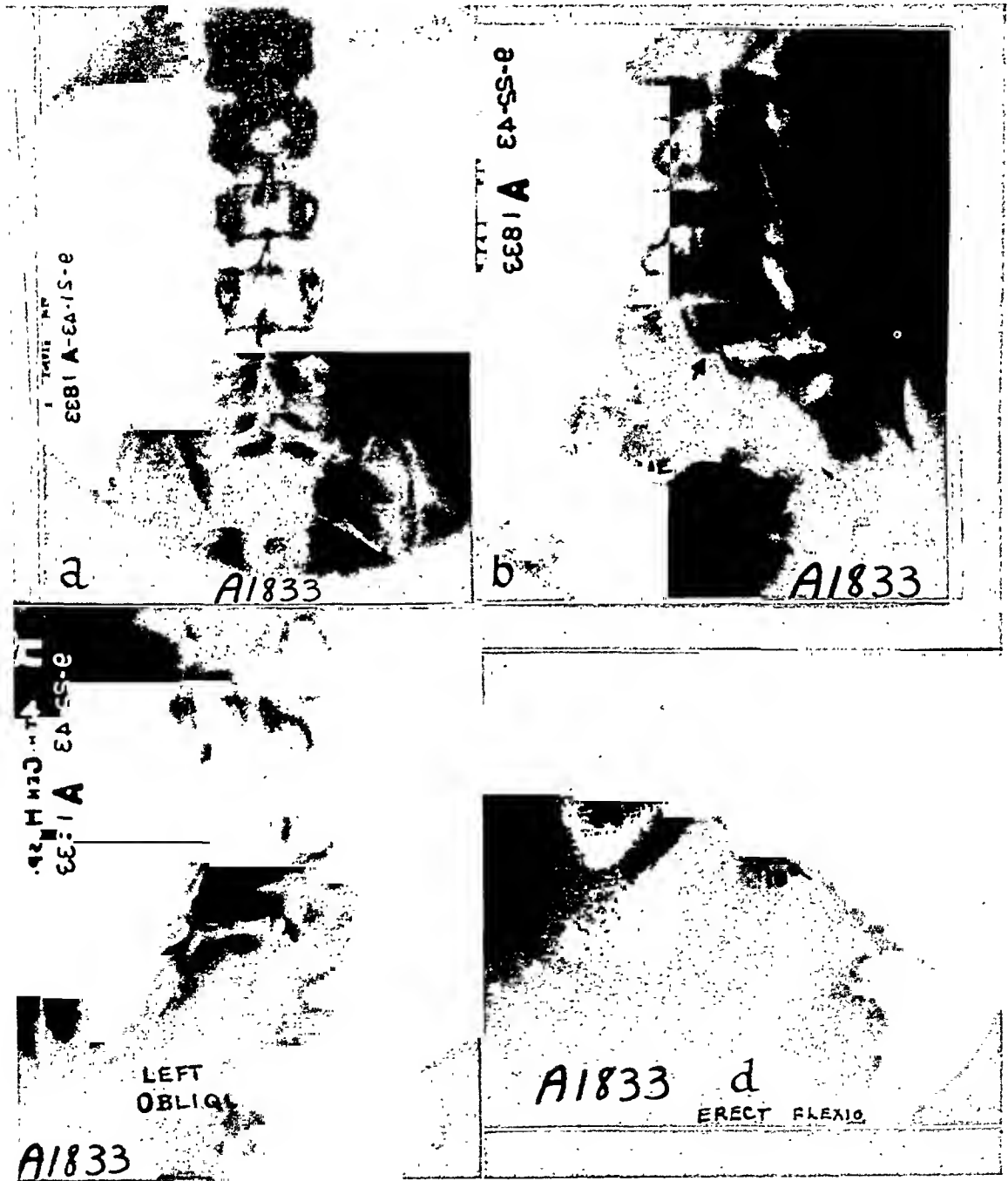


FIG. 6. See opposite page for legend.

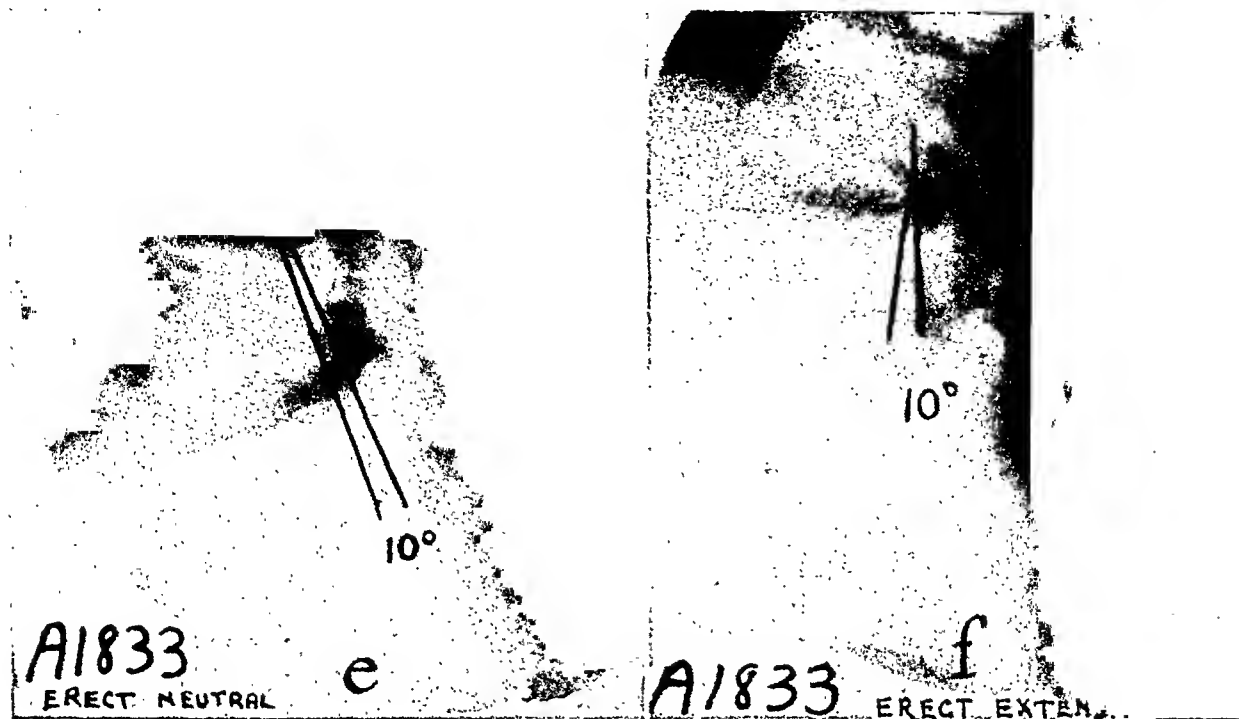


FIG. 6, *a, b, c, d, e* and *f*. Case A1833. Spondylolisthesis with no instability. Angle of displacement is  $10^{\circ}$  in all lateral views. The spondylolysis interarticularis is clearly shown. There is an associated spina bifida of the affected vertebral body.

*Case Résumé.* This soldier, aged twenty, who was admitted for malaria, fell off a tram one month previously. He complained of occasional back pain intermittently. There was no back disability. *Disposition:* duty.

fect. Occasionally, with wider separation of the fragments, the superior facet of the vertebra below appears to project directly into the defect, partially obscuring it.

Although the outline of the fragments appears jagged, there is a softness of definition of the margins. It is not certain that fracture can be considered a possibility; if so, however, the appearance is usually that of a remote, ununited fracture without any evidence of bone repair or absorption.

Willis found an incidence of 5.2 per cent of defects of the pars interarticularis in 1,520 human skeletons selected at random, varying in age from twenty-five to ninety years. The incidence was equal in the various age groups.

Among 1,131 roentgenographic lumbosacral spine examinations (Table 1) in twenty-two months, we found 5.1 per cent with this defect (57 cases). This number includes the 41 cases of spondylolisthesis. All of these examinations were carried out on patients complaining of low back pain.

Our series is not comparable with that of Willis, since the latter included adult skeletons selected at random, whereas our patients were soldiers carefully selected for Army service who complained of back pain.

Defects of the pars interarticularis (usually found in the fifth lumbar vertebra) comprised approximately one-eighth of all anomalies of the lumbosacral region, including sacral spina bifida. They were one-fifth as frequent as all types of spina bifida. For the sake of convenience, we have considered defects of the pars interarticularis among the lumbosacral anomalies, but we are by no means certain that this defect is truly an anomaly. This matter has been discussed previously.

Seventy-two per cent of cases with defects of the pars interarticularis also had a spondylolisthesis, and 28 per cent did not.

*B. Anteroposterior Views.* Willis<sup>7</sup> maintained that, in cadavers with known defects in the pars interarticularis, he frequently found it impossible to detect posi-

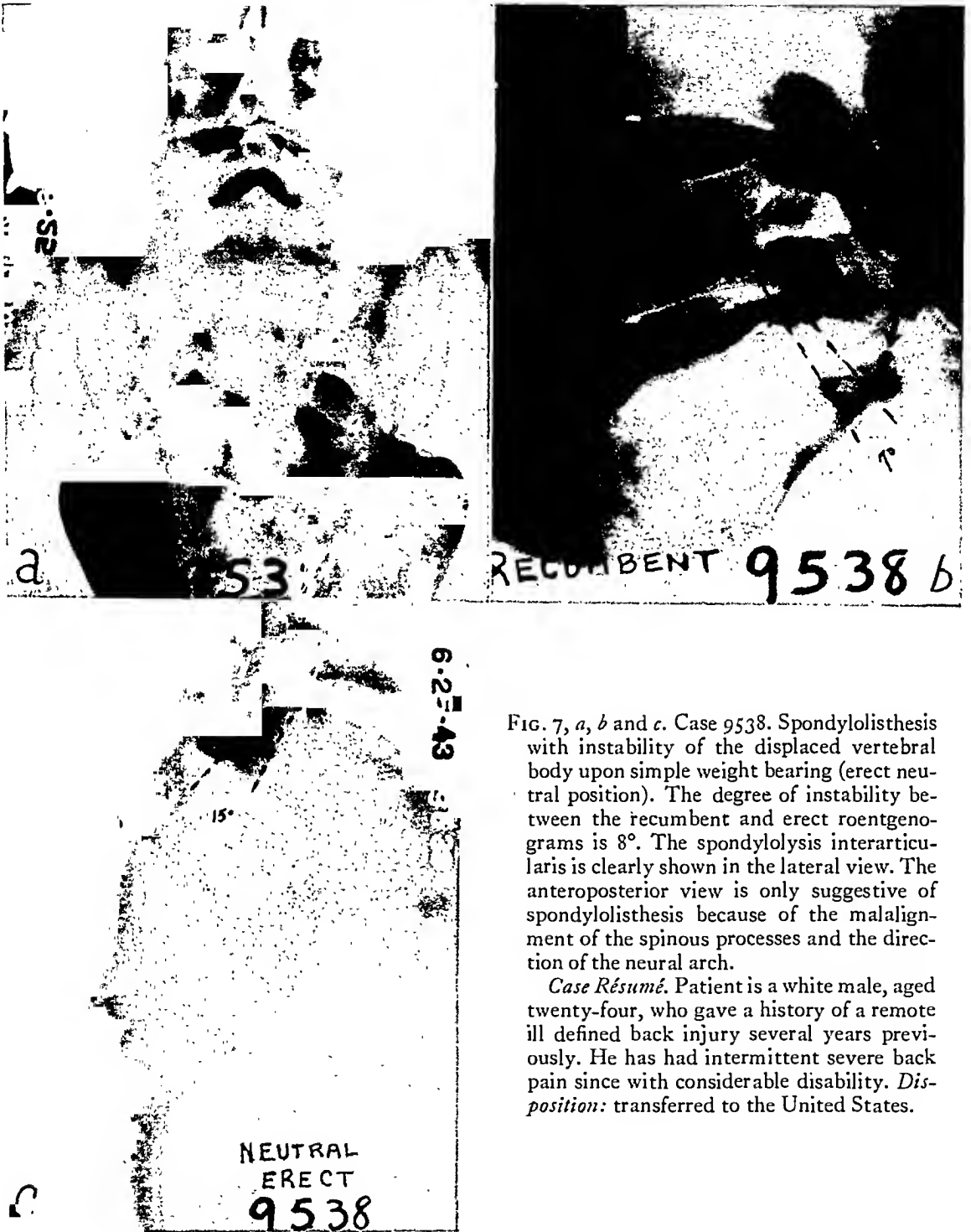


FIG. 7, *a*, *b* and *c*. Case 9538. Spondylolisthesis with instability of the displaced vertebral body upon simple weight bearing (erect neutral position). The degree of instability between the recumbent and erect roentgenograms is  $8^\circ$ . The spondylolysis interarticularis is clearly shown in the lateral view. The anteroposterior view is only suggestive of spondylolisthesis because of the malalignment of the spinous processes and the direction of the neural arch.

*Case Résumé.* Patient is a white male, aged twenty-four, who gave a history of a remote ill defined back injury several years previously. He has had intermittent severe back pain since with considerable disability. *Disposition:* transferred to the United States.

tive roentgenographic evidence of the condition. He recommended the anteroposterior stereoscopic views as the most satisfactory—but even with this method the diagnosis was apparently made by inference from “a delimitation laterally of the lami-

nae” which he came to regard as diagnostic of the condition. In our studies, we have found the anteroposterior projection helpful, but not diagnostic. Apart from the delimitation of the laminae laterally which Willis described for detection of defects in

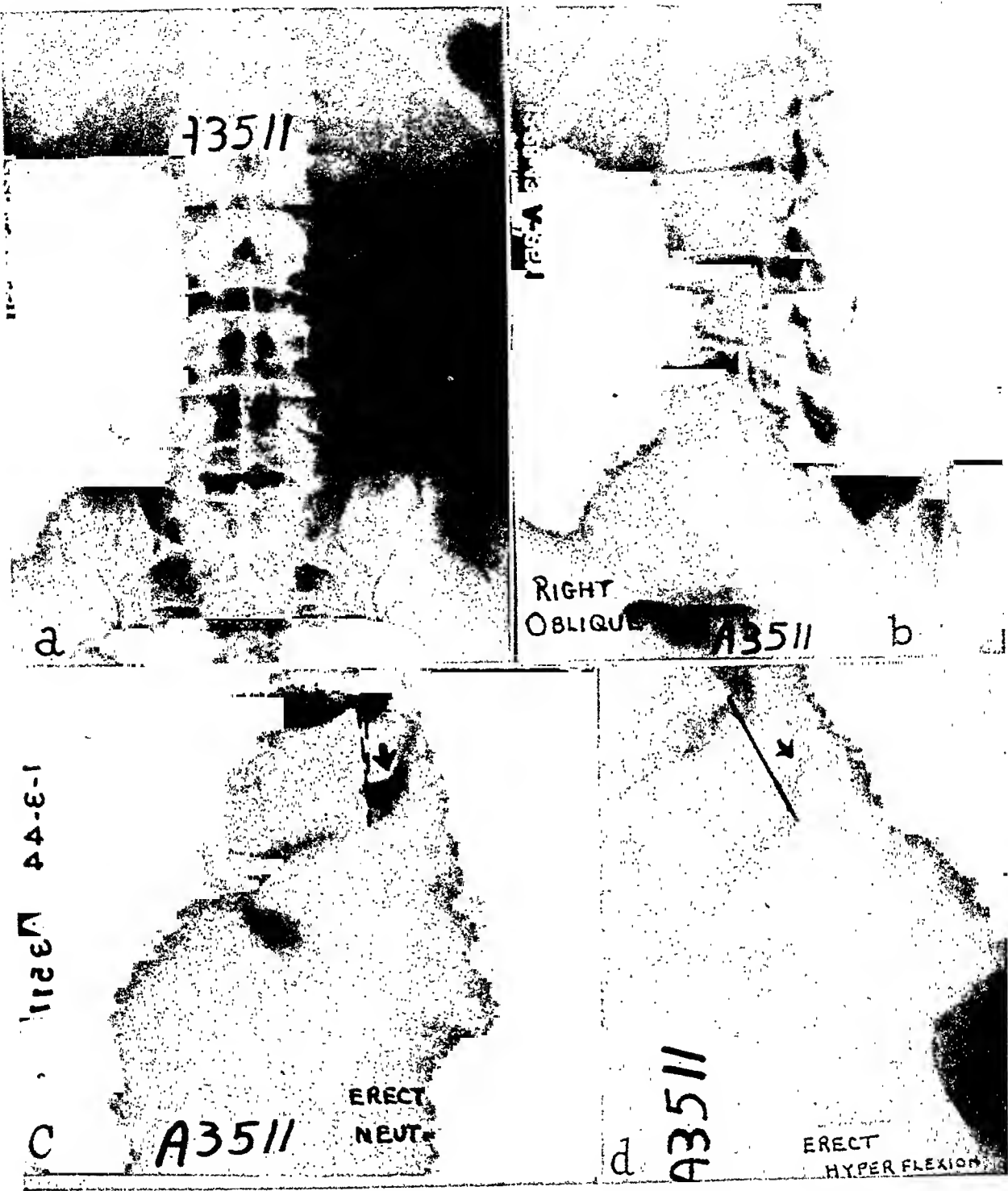


FIG. 8, a, b, c and d. Case A3511. Bilateral spondylolysis interarticularis without spondylolisthesis. Only one oblique view with an unusual small defect in the pars interarticularis is shown. The defect on the other side is typical and not shown. The roentgenogram in erect hyperflexion shows the accentuation of the defect in hyperflexion. The diagnosis could not be made from the anteroposterior projection.

*Case Résumé.* White male, aged twenty-three, with low lumbar backache, associated with nonspecific urethritis. There was no history of trauma. *Disposition:* full duty.

the pars interarticularis, there are other findings which are contributory to the diagnosis of the spondylolisthesis:

1. The spinous process may be out of line with respect to the spinous process above it (Fig. 7).
2. In advanced spondylolisthesis, the body of the slipped vertebra is projected



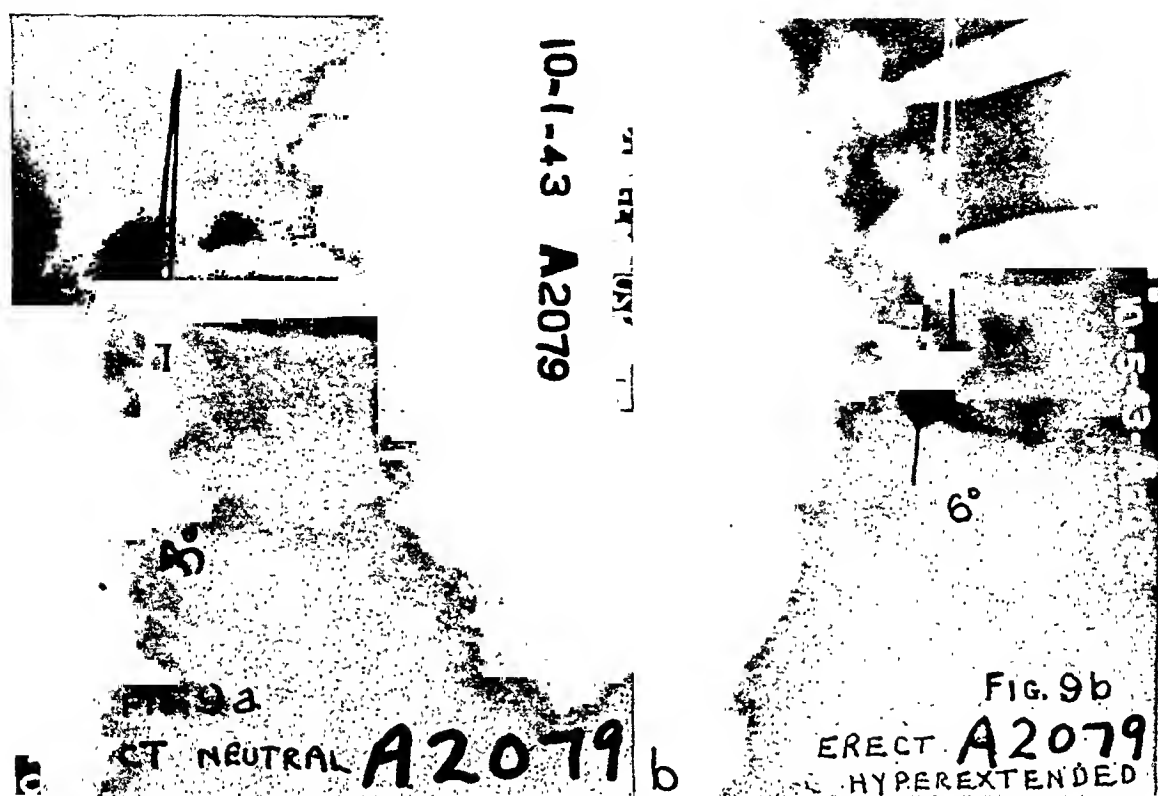


FIG. 9, *a* and *b*. Case A2079. Spondylolisthesis with instability demonstrated by hyperextension of the spine, but not by simple weight bearing in the neutral position. The instability between the erect neutral and hyperextended positions is  $3^{\circ}$ . The slipped vertebral body is the fourth lumbar. The spondylolysis interarticularis is clearly shown.

*Case Résumé.* Patient is a white male, aged thirty-two, who was twice thrown from a horse—first in 1942, next seven months ago. Previous roentgenographic studies in 1942 were reputedly negative elsewhere. His chief complaint was pain radiating down his left thigh on bending. *Disposition:* transferred to the United States.

as superimposed upon the upper sacrum, and its spinous process points upward (the so-called "bow and arrow" appearance).

This condition is also frequently associated with lumbosacral anomalies (49 per cent, Table I). However, lumbosacral anomalies were found in 41.4 per cent of all lumbosacral examinations. With such a high incidence of anomalies, and such a relatively low incidence of spondylolisthesis (3.6 per cent), this factor is hardly of much value in diagnosis.

None of these findings in the anteroposterior view are diagnostic; not infrequently they are misleading. The lateral and oblique views must always be taken to prove or disprove what is suspected from the anteroposterior study, not only with regard to spondylolisthesis but also with

regard to defects in the pars interarticularis.

*C. Lateral Views.* In the lateral views, the defect in the pars interarticularis is seen as a discontinuity in the neural arch of the involved vertebra along the posterior margin of the spinal canal (Fig. 6, 7, 8 and 9). In contrast to the appearance in the oblique projections where the margins of the defect appear very irregular and saw-toothed, the defect as seen in the lateral projection usually appears more rounded and smooth. The defect is seen most clearly in the lateral projection when the spine is flexed (Fig. 8) and could be overlooked if this additional view were not obtained.

In lumbar spine anatomic specimens of "the separate neural arch," Willis found a marked bevelling of the sacrum and associated hypertrophic changes. The roent-

genographic counterpart of these changes is best seen in the lateral views. The upper anterior margin of the sacrum is rounded, and the entire upper surface presents a horizontal S configuration. The interspace below the slipped vertebra is usually narrowed. There may be associated bony liping and sclerotic changes of the adjoining bony surfaces of this interspace. These changes are attributed to the rocking movement of the loose vertebral body on the upper surface of the sacrum (Fig. 6 and 7).

#### SUMMARY

1. Spondylolisthesis can be recognized by means of the position of the apex of the angle formed when lines are drawn as described. The apex always falls above the vertebral body in question. If the lines are parallel the distance between them is 4 millimeters or more.

2. The degree of spondylolisthesis can be accurately measured, by determining the angle between these lines, if an angle is formed. In a few cases (3 out of 41), the lines may be parallel, and the linear distance between them is then measured.

3. This method of mensuration is also used in the determination of the degree of instability of a slipped vertebral body by comparing lateral roentgenograms of the lumbosacral spine taken with the patient lying down, and standing in the neutral, hyperflexion, and hyperextension positions.

4. The cases of spondylolisthesis observed at this overseas Army general hospital in twenty months are reviewed with regard to these special methods of examination. Among 1,131 lumbosacral spine studies, 41 cases of spondylolisthesis were noted in 57 patients with defects of the pars interarticularis.

5. The displaced vertebral body in spondylolisthesis may or may not be stable. Thus, 7 of the 41 cases of spondylolisthesis were found to be unstable; 4 of these could be demonstrated by comparison of the recumbent with the weight-bearing (stand-

ing) neutral roentgenogram: 3 cases revealed instability only after a roentgenogram in hyperextension was compared with the other views.

6. The value of the oblique roentgenogram of the lumbosacral spine for demonstration of defects of the pars interarticularis is emphasized. There is an incidence of over 5 per cent of this defect.

7. Objection is made to referring to spondylolisthesis universally as a congenital anomaly. The evidence at hand suggests that trauma may widen the defect, initiate the symptoms, and start the displacement of the vertebral body. An unequivocal opinion in either direction cannot be stated.

I am especially indebted and grateful to: Lieutenant Colonel Eugene Freedman, with whom the project was originally discussed, and in whose department the roentgenographic studies were made; Major W. H. McGaw, for his valuable aid in the organization of the material presented herein, and for his careful criticism of the compiled data, and Lieutenant Colonel D. M. Glover, who originally encouraged us to study cases of spondylolisthesis with views taken in hyperextension and hyperflexion.

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# PLEURITIC INVOLVEMENT ASSOCIATED WITH PRIMARY ATYPICAL PNEUMONIA

## A ROENTGENOGRAPHIC AND CLINICAL STUDY

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DURING the course of routine roentgenograms of the chest in the examination of a large number of soldiers, pulmonary findings characteristic of atypical pneumonia were observed in about 0.3 per cent of the examinees. In this group, pleuritic involvement, particularly of the lower ends of the interlobar fissures, was found in a comparatively large percentage. In view of the interesting, consistently similar roentgen findings and the infrequency of reports of pleural manifestations in primary atypical pneumonia, a detailed report of these cases is presented.

A comprehensive review of the extensive literature concerning atypical pneumonia and related syndromes revealed relatively few reports of associated pleural involvement.<sup>3,10,31,33,36</sup> Of these, a considerably smaller percentage was described as involving the interlobar fissure. Reimann<sup>29</sup> reported 11 cases of clinically severe atypical pneumonia and recorded pleuritic processes in four. Two of these showed a thickening of the interlobar pleura, and in 1 case a small collection of sterile fluid was found in the costophrenic sinus. Dochez<sup>5</sup> noted that it was not unusual for the pleura to be affected during the course of this disease. A tendency toward involvement of the interlobar pleura in clinically severe cases was also reported by Smiley, *et al.*<sup>34</sup> Findings similar to our own were described by Crysler<sup>4</sup> in 178 cases. He recorded pleurisy with effusion as occurring only rarely, but found evidence of co-existing interlobar or parieto-visceral pleural thickening in 22 of the cases

in which the parenchymal infiltrations were situated adjacent the pleura. In the large majority of other reports either no pleural involvement was mentioned or rare occurrences of clouding of the costophrenic sinus were noted (Table 1).

The anatomical course of the interlobar fissures in the frontal and lateral view roentgenograms is shown in composite diagrams (Fig. 1, *A* and *B*) derived from Gray,<sup>12</sup> Levitin and Brunn<sup>17</sup> and from our own roentgenograms made during deep inspiration. The location, shape and appearance of the fissures in the oblique views are well demonstrated in the cadaver studies and illustrations of Peirce and Stocking<sup>26</sup> (Fig. 2). The lower ends of the long fissures on either side are of particular interest for this report. In the frontal view, the right long fissure extends obliquely downward and inward, reaching the diaphragm in the cardiophrenic angle at about the level of the seventh costal cartilage. On the left side the long fissure extends downward and inward in a similar manner, but crosses the dense shadow of the lower left lateral margin of the heart just before reaching the diaphragm opacity also at about the same level. In the lateral view, the appearance of both long fissures is essentially the same. The lower halves of these fissures are seen only through the opacity of the cardiac shadow and, at their inferior ends, the fissures dip just below the densities of the anterior edges of the diaphragms. A considerable difference is noted between the lower portions of the right and

TABLE I

REVIEW OF LITERATURE: ROENTGENOGRAPHIC PLEURAL MANIFESTATIONS WITH ATYPICAL PNEUMONIA

Authors	Total Cases Atypical Pneumonia	Cases with Pleurisy	Location of Pleurisy		Pleural Involvement
			Costo- phrenic Sinus	Interlobar Fissure	
					Per cent
Reimann <sup>29</sup>	11	4	2	2	36.4
Miller and Hayes <sup>23</sup>	35	1	—	—	2.8
Murray <sup>24</sup>	81	1	—	—	1.2
Goodrich and Bradford <sup>10</sup>	52	2	—	—	3.8
Green and Eldridge <sup>11</sup>	110	1	—	—	0.9
Haemig and Heyden <sup>15</sup>	59	2	—	2	3.4
Rhoads <sup>31</sup>	31	2	—	—	6.5
Hufford and Applebaum <sup>14</sup>	27	1	1	—	3.7
Campbell, <i>et al.</i> <sup>3</sup>	200	12	—	—	6.0
Needles and Gilbert <sup>25</sup>	125	1	—	—	0.8
Crysler <sup>1</sup>	178	22	—	—	12.3
Warren, Higley and Harrison <sup>56</sup>	480	22	22	—	4.6
Showacre, <i>et al.</i> <sup>33</sup>	196	?	—	—	0-3.0
					varying with season
McCarthy <sup>22</sup>	590	Rare	—	—	—
Kneeland and Smetana <sup>15</sup>	52	Occasional	—	—	—
Drew, Samuel and Ball <sup>6</sup>	50	Occasional	—	—	—
Others <sup>1,7,9,16,19,20,21,28,30,32,37</sup>	782	0	—	—	0

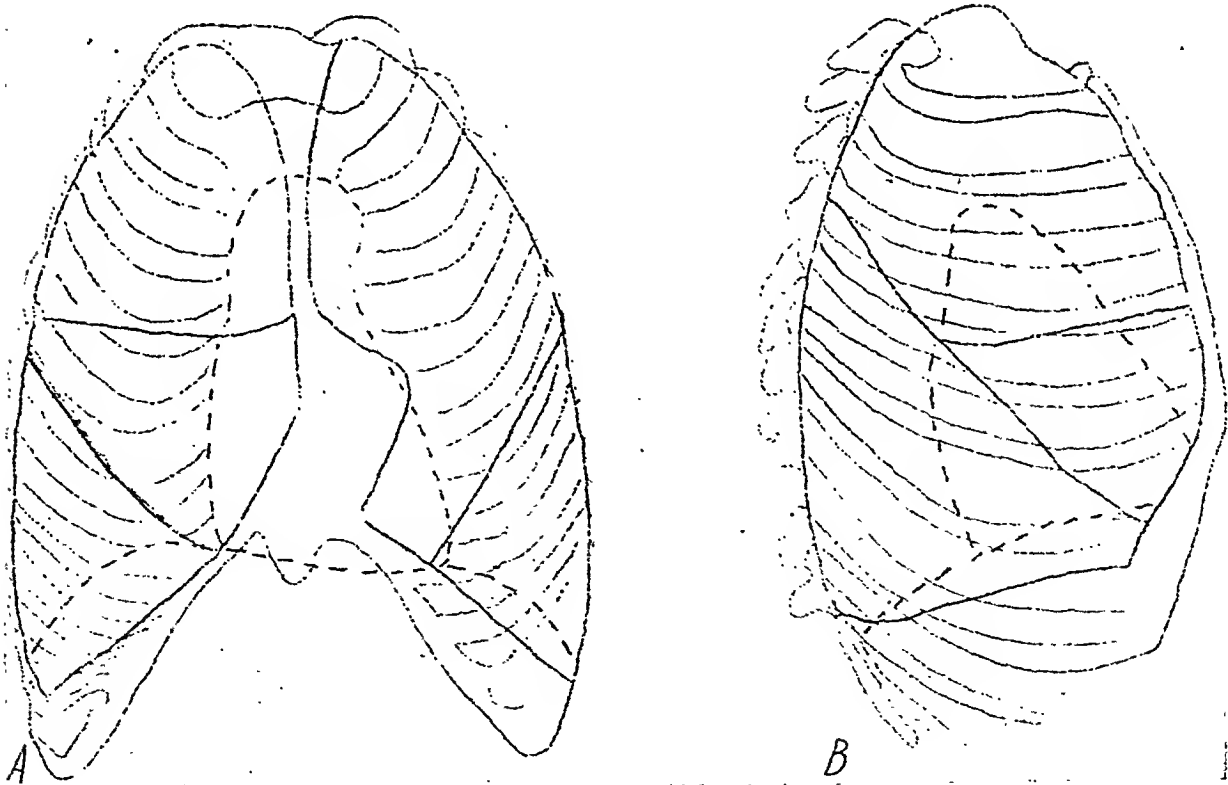


FIG. 1. *A*, appearance of fissures in frontal view. *B*, appearance of fissures in lateral view. The long fissures in the right and left lungs occupy the same position.

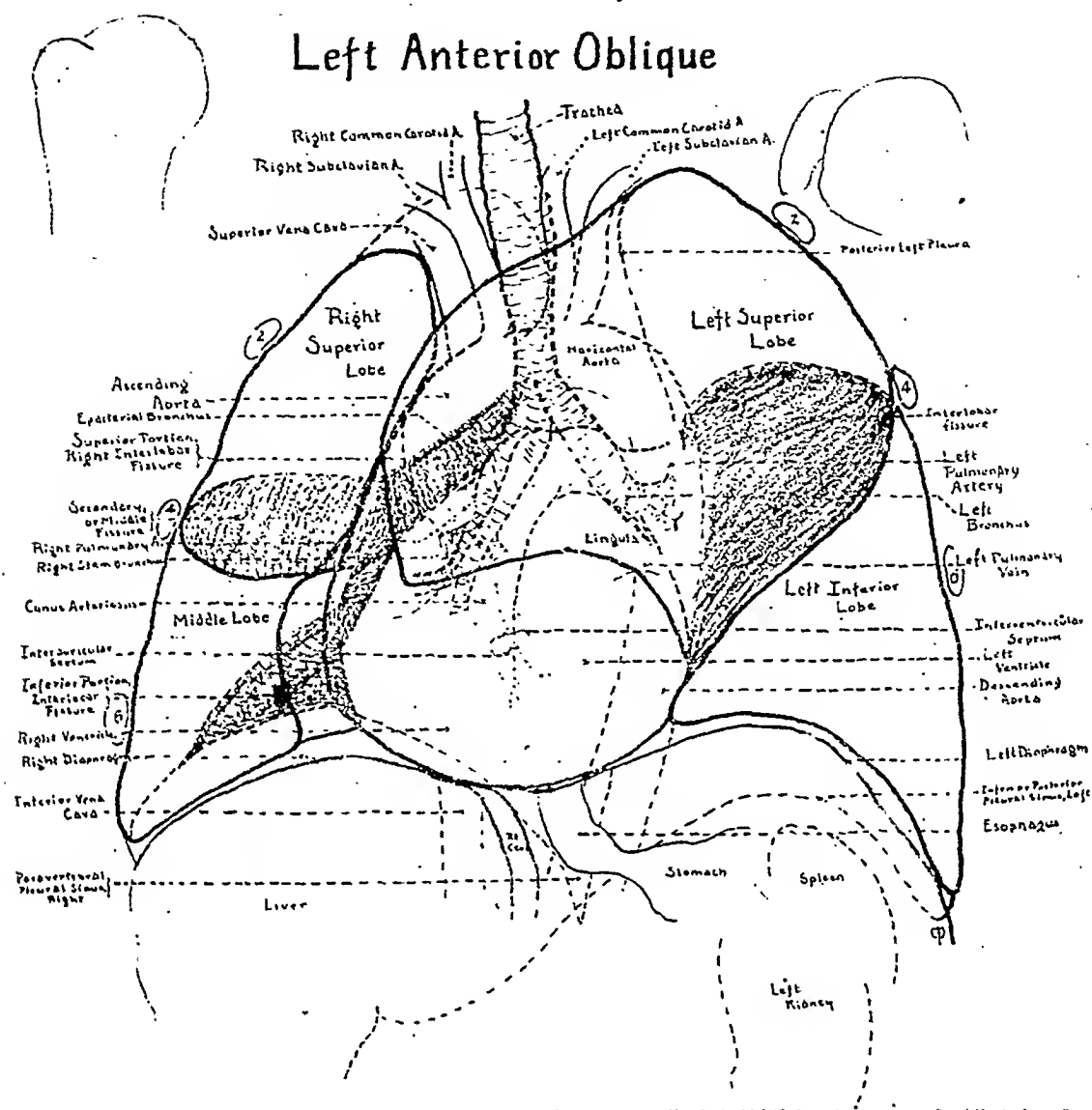


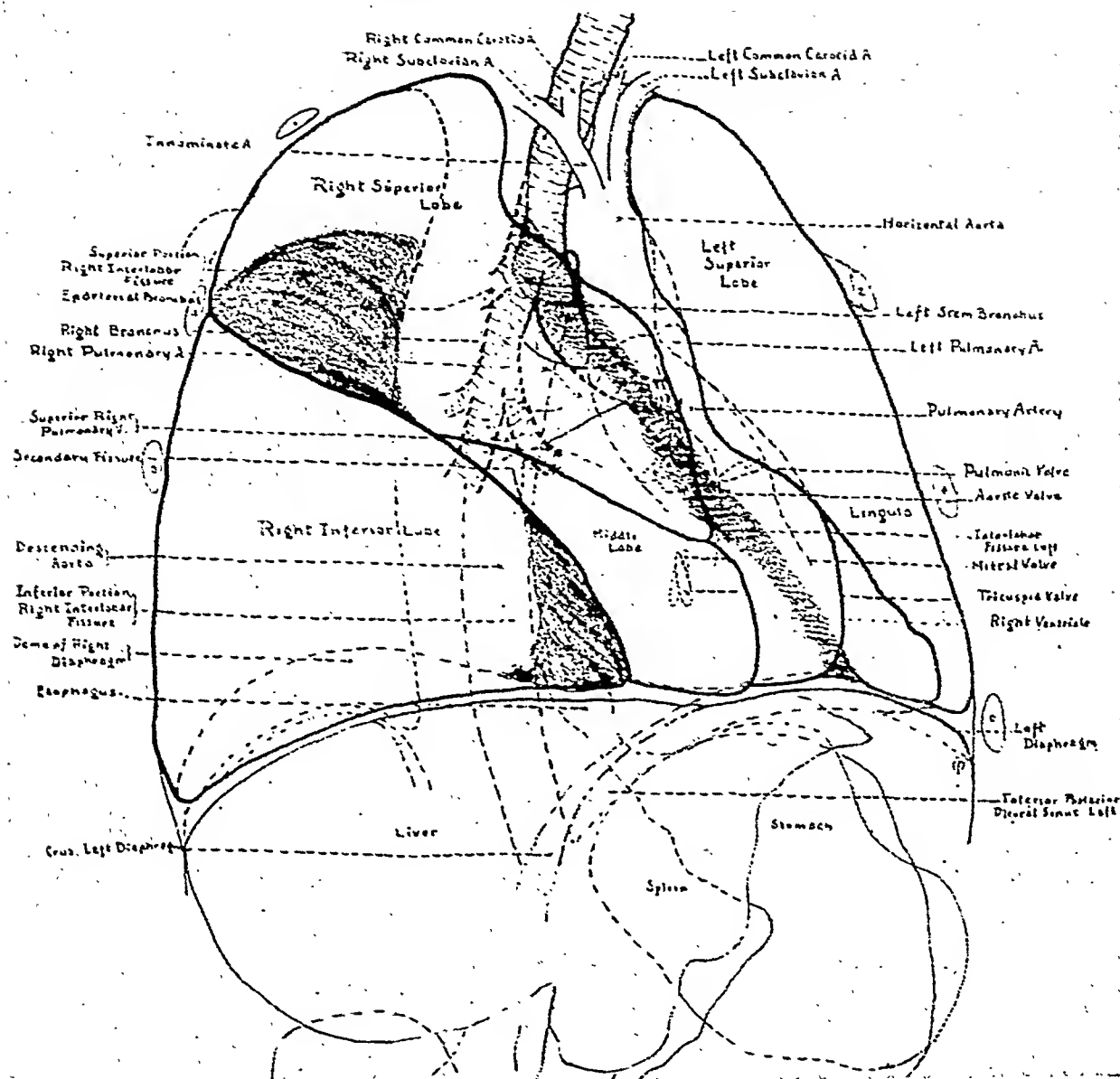
FIG. 2. Appearance of fissures in the oblique views. The

left main fissures in the oblique view. In the left anterior oblique view the inferior end of the right long fissure is triangular in shape and rests on the mesial surface of the diaphragm adjacent the lower right anterior border of the heart. However, in the right anterior oblique roentgenogram, the inferior half of the left long fissure is merely band-like in appearance and, for most of its length, is obscured by the overlying cardiac density. Only the small portion of its lower end which rests on the diaphragm extends

beyond and lies adjacent to the lower left anterior border of the heart.

Our series of primary atypical pneumonia consisted of 144 cases. Of these, 21 (14.5 per cent) showed definite evidence of pleural involvement (Table II). In 11 cases (7.6 per cent) there was a pleuritic process essentially limited to the lower end of the longitudinal fissure with little or no roentgenographic evidence of adjacent pulmonary parenchymal involvement. Seven cases (4.8 per cent) showed an atypical pneu-

## Right Anterior Oblique



area and position they occupy are shaded a dark gray.

monic type of infiltration associated with thickening of the lower end of the long fissure. The infiltrations were either in lobes adjacent to the involved fissure or in the opposite lung. In 3 cases (2.1 per cent) the costophrenic sinus was the site of the pleuritis and the long fissures appeared normal. One of these patients showed a considerable effusion in the general pleural space.

The clinical syndrome of 20 cases with pleuritic involvement was essentially iden-

tical with that of the remaining 123 cases of primary atypical pneumonia without evidence of pleuritis. The course of the 1 patient with extensive pleural effusion was somewhat more protracted. The cases appeared sufficiently similar to permit a discussion of the clinical manifestations of the group as a whole. The entire series of 144 cases was found during a routine processing chest examination employing a photoroentgen apparatus. The pulmonary abnormalities were clearly visualized on the stereo-

scopic pair of 4 by 5 inch films. Regular 14 by 17 inch films were used in the confirmatory studies.

The majority of the examinees, although found to have respiratory tract symptoms on questioning, were not sufficiently incapacitated to seek medical aid. A small number of these patients who attended sick call for "colds" had normal temperatures and no abnormal physical findings in their chests.

TABLE II  
PLEURAL INVOLVEMENT IN 21 CASES OF  
PRIMARY ATYPICAL PNEUMONIA

	Cases
I. Lower ends of long fissures involved with no or minimal co-existing process in pulmonary parenchyma.....	11
Right long fissure.....	7
Left long fissure.....	4
II. Lower ends of long fissures involved with a significant co-existing process in pulmonary parenchyma.....	7
Right long fissure.....	3
Left long fissure.....	4
III. Costophrenic sinus pleural involvement with a significant co-existing process in adjacent pulmonary parenchyma.....	3
Right sinus.....	1
Left sinus.....	2*

\* One of these patients had an extensive effusion involving the general pleural cavity.

The patients were eighteen to twenty-six years of age. The duration of symptoms prior to the discovery of the pulmonary process varied from one to two weeks in the majority of cases. In a few instances, they were of four days' duration, and 1 patient had been coughing for two months. Cough was the most common complaint. It was almost invariably worse at night and often produced a moderate amount of mucoid or mucopurulent sputum. Malaise, chilliness (but not shaking chills), headache and sore throat were the other symptoms most often encountered. A pleuritic type of chest pain on deep inspiration was noted by several patients. Occasionally, there was no complaint at the time of examination although

a history of respiratory tract infection in the preceding month could frequently be elicited.

Physical findings were extremely meager in the majority of cases. Several examinees showed no abnormal chest findings of any kind. The breath sounds were usually of normal character but either diminished or slightly exaggerated in intensity. Bronchial breathing was not heard. Varying grades of dullness, usually slight, were found on percussion over the affected regions. A large proportion of the cases presented râles which were sticky, subcrepitant and/or rhonchial in nature. In a number of patients a friction rub was heard in the anterolateral portion of the chest below the nipple area. Mild nasopharyngitis was commonly found, often being associated with slight enlargement of the cervical lymph glands.

Temperature, pulse, urine, leukocyte count and differential blood count were normal in the great majority of instances. Abnormalities, when present, were never marked. The highest temperature was 102° F., returning to 98° F. in three days. The highest white blood cell count recorded was 12,650 per cu. mm., with only a slight shift of the leukocytes to the left. Sedimentation rates varied between 22 and 34 mm. fall per hour (Cutler method) in the majority of cases where this procedure was performed. Sputum examinations were done in only 2 cases and showed no significant findings.

The duration of the illness was determined by the length of time required to obtain an essentially normal roentgenographic appearance of the chest. Most frequently the patients were asymptomatic a considerable time before the chest roentgenograms appeared normal. In the majority of cases the chest roentgenogram appeared essentially normal in two to four weeks. Several cases showed complete resolution in one week and in 1 patient an associated extensive pleural effusion persisted for two and a half months.

The roentgenographic appearance of thickening of the lower end of the long fissure, due to exudate and/or moderate



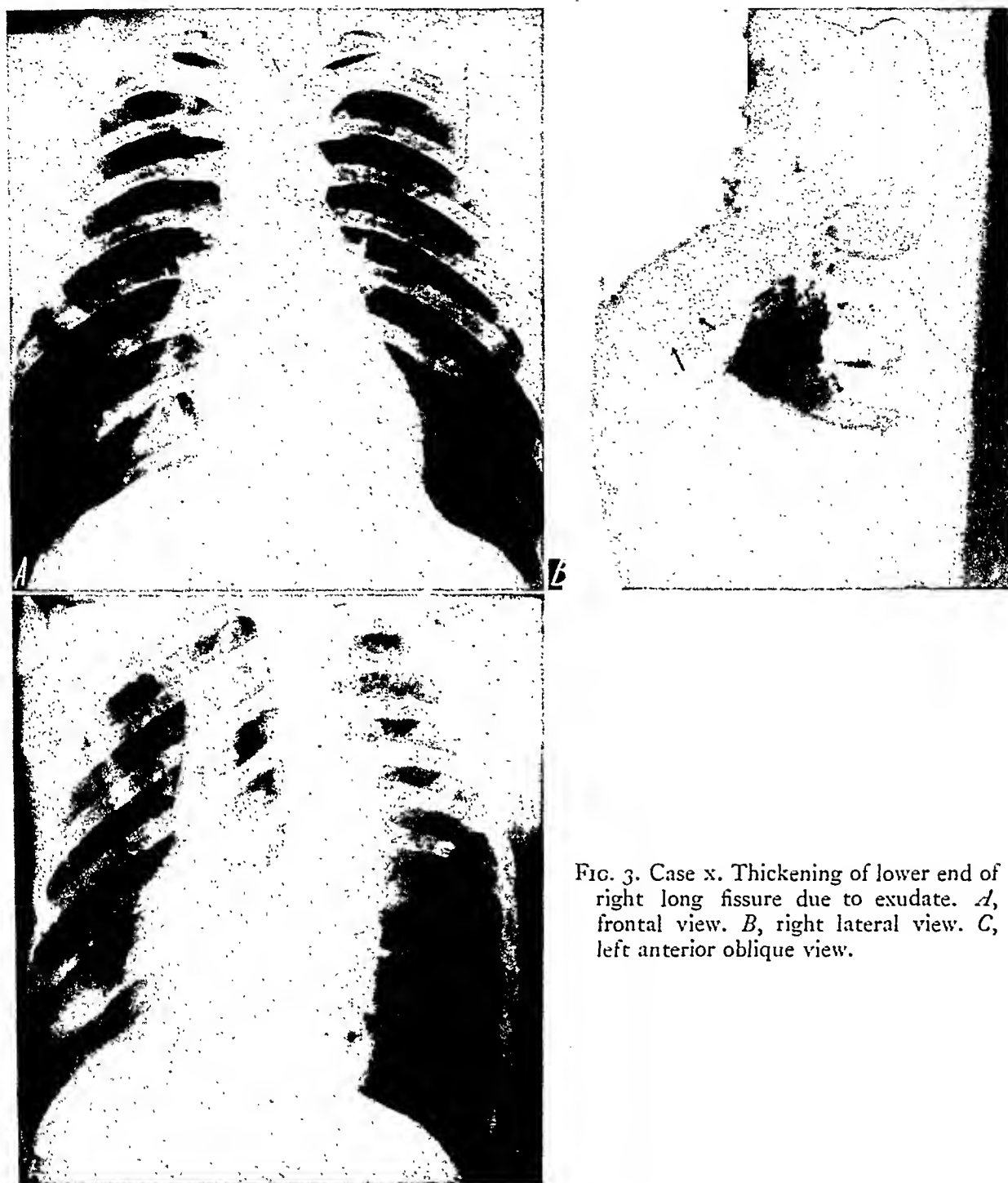


FIG. 3. Case x. Thickening of lower end of right long fissure due to exudate. *A*, frontal view. *B*, right lateral view. *C*, left anterior oblique view.

amounts of effusion, was quite characteristic. In the frontal view was seen a rather limited area of homogeneous opacity in the lower lung field, adjacent the heart, which always extended down to the diaphragm in the cardiophrenic angle (Fig. 3, 5, 6 and 7). Failure of the opacity to overlap the diaphragmatic shadow was found to be strong evidence against the diagnosis of exudate in the lower interlobar fissure. The lateral

margin of the opacity was well demarcated from the surrounding pulmonic tissue and did not extend laterally beyond the mid-clavicular line. Fuzziness or streaking at the margins was not observed unless there was an adjacent parenchymal involvement. The density of the opacity varied with the amount of exudate or fluid that was present between the lobes. In some instances, the homogeneous haze was comparatively



FIG. 4 Case x. Almost complete resolution after two weeks.

slight in the frontal view and quite dense in the lateral and oblique views (Fig. 7). In others, the shadow was quite opaque in the frontal view. When the lower end of the left long fissure was involved, blurring of the usually sharp left lower cardiac border was uniformly observed (Fig. 5A). Seen through the homogeneous moderate densities in the cardiophrenic angles were the normal, somewhat denser, pulmonary markings which coursed from the hila to the medial portions of the lower lobes be-

hind the anteriorly located fissures. These markings were never found exaggerated in size or increased in number if only an interlobar fissure exudate was present (Fig. 3A and 7A). The presence of increased pulmonary markings in the lower lobes was always found to indicate a lower lobe pneumonic process, identified by examination in other views.

Examinations made in the lateral view clearly showed the thickening of the lower portion of the interlobar fissure. The den-

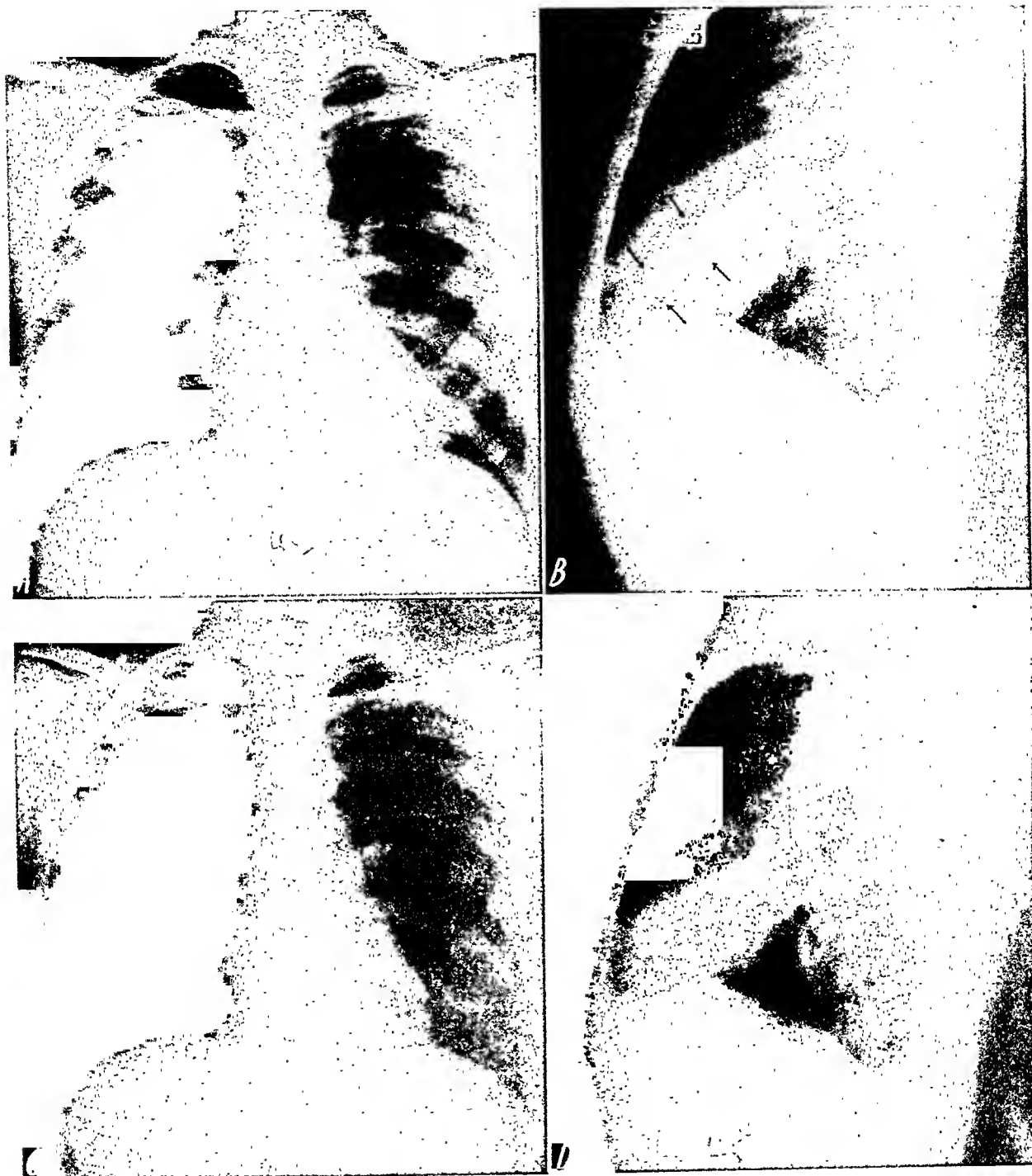


FIG. 5. Case XIII. *A*, frontal view. Note blurring of left lower cardiac margin. *B*, left lateral view. Thickening of lower end of left long fissure due to exudate. *C*, complete resolution in five weeks, frontal view. *D*, lateral view.

sity was observed in the region of the junction of the diaphragmatic shadow with that of the anterior chest wall and extended upward for a variable distance along the course of the interlobar fissure. It was band-like in appearance and varied in thickness, depending upon the amount of exudate present (Fig. 3*B*, 5*B* and 7*B*). Less fre-

quently, fluid was present and the opacity tended to assume a typical fusiform shape (Fig. 6*B*). In the antero-inferior end of the long fissure at its junction with the diaphragm, the density was occasionally irregular and knob-like in appearance due to the pleuritic inflammatory process extending out into the anterior free pleural space be-

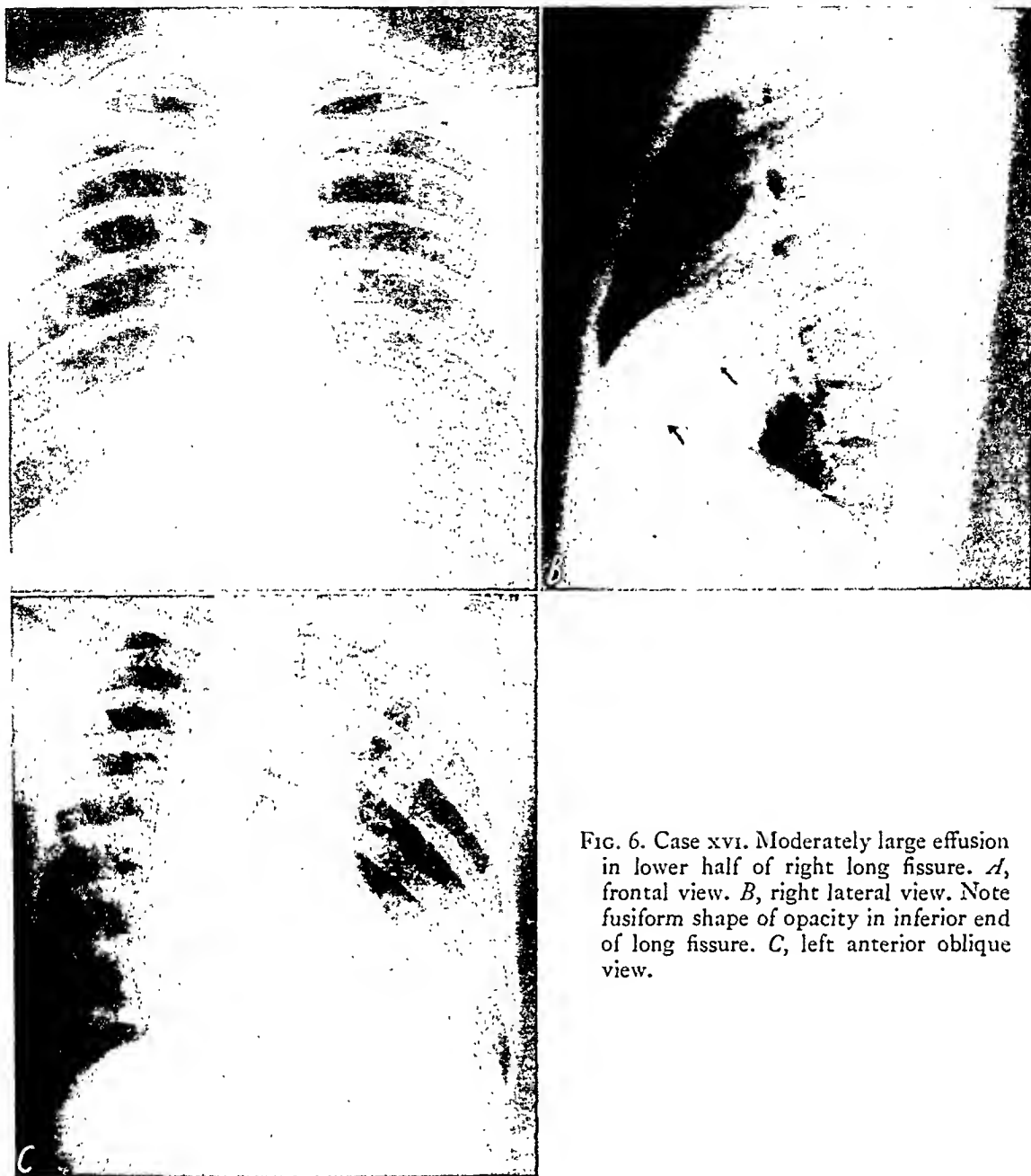


FIG. 6. Case xvi. Moderately large effusion in lower half of right long fissure. *A*, frontal view. *B*, right lateral view. Note fusiform shape of opacity in inferior end of long fissure. *C*, left anterior oblique view.

yond the end of the fissure (Fig. 3*B* and 7*B*). Occasionally, small, less opaque patchy areas of pneumonic infiltration were seen adjacent to the thickened pleura.

The appearance on the oblique roentgenograms was also characteristic. Involvement of the right lower fissure was best demonstrated in the left anterior oblique view (Fig. 3*C* and 6*C*). The thickened lower end of the long fissure was seen as a rather homogeneous, triangular opacity in the

anterior portion of the right lower lung field immediately adjacent the lower right cardiac outline, and lying on the mesial half of the diaphragm. The upper side of the triangle was arc-like, convexity cephalad, and the apex was located on the diaphragm. In this view, the normal pulmonic markings of the right lower lobe were well separated from the opacity of the thickened fissure and the homogeneous appearance of the shadow was not disturbed by pulmonic

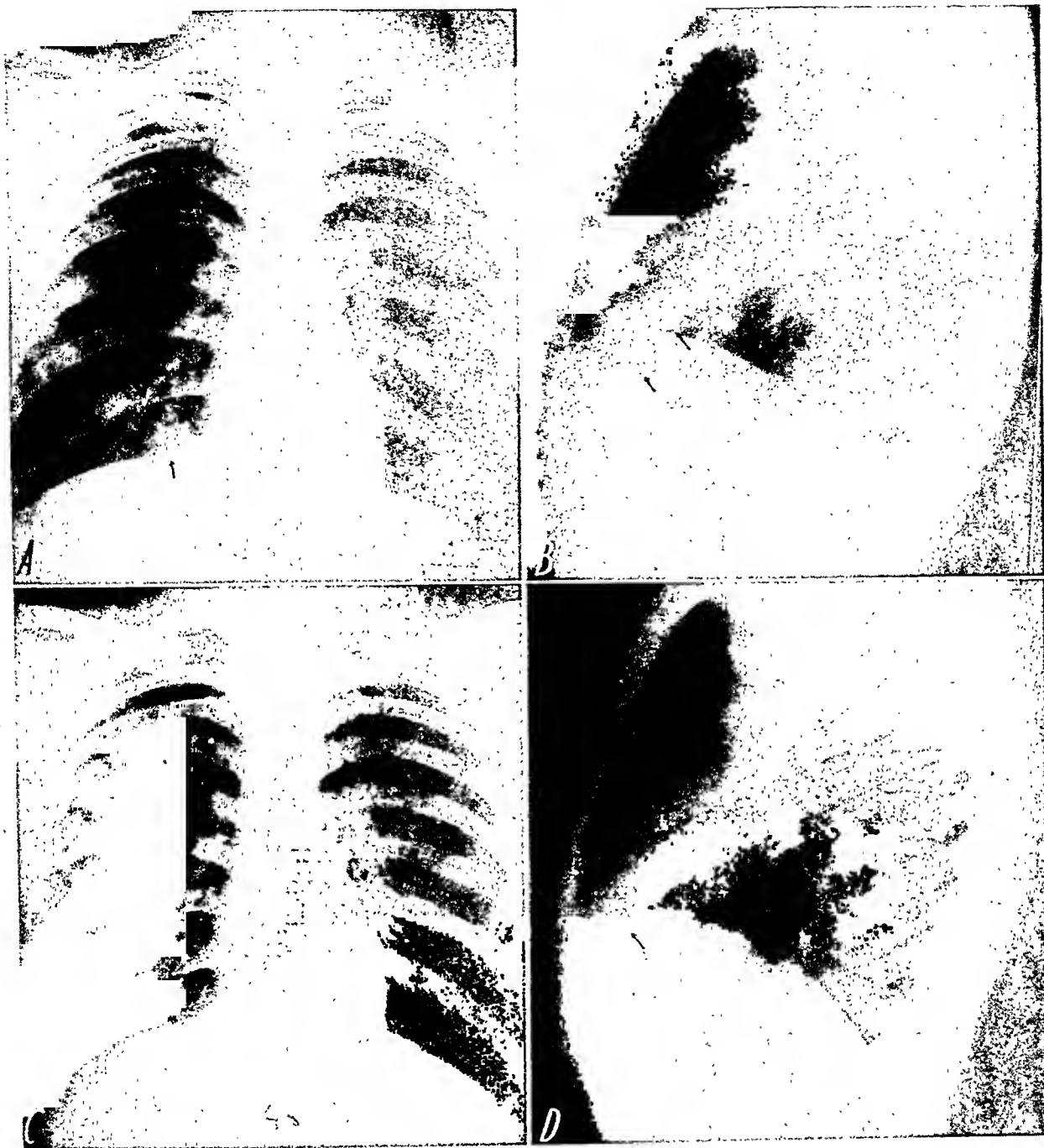


FIG. 7. Case 1. *A*, frontal view. Small opacity in right lower lung field mesially due to exudate in lower end of right long fissure. Normal pulmonary markings in this region are clearly demonstrated. *B*, right lateral view. Note knob-like density at junction of diaphragm with antero-inferior end of long fissure. *C*, same case. Resolution progressing well, frontal view. *D*, lateral view.

markings coursing through it. The right anterior oblique position was employed to demonstrate involvement of the lower portion of the left long fissure. In this view a considerable portion of the band-like opacity was situated within the denser shadow of the lower left anterior portion of the heart, and the homogeneous triangle of density due to the thickened pleura was

considerably smaller than on the right side but had the same general features.

Obliteration of the costophrenic sinus by varying amounts of pleural effusion or exudate resulted in the usual characteristic appearance.

In a large number of cases, roentgenographic evidence characteristic of atypical pneumonia was found to be associated with

the pleural exudates. In some, the lesions were in the adjacent lobes, while in others, the pneumonitis was in the contralateral lung. They appeared as linear, linear and small patchy, faintly dense patchy or confluent moderately opaque infiltrations.

The average duration of the pleural exudate was from two to four weeks. Roentgenograms of the chest taken after this period usually showed complete disappearance of the originally observed opacity. Occasionally, however, light residual thickening of the involved interlobar fissure was noted. Pleural effusions persisted somewhat longer than exudative thickening of the pleura without fluid. When pleural involvement was associated with a parenchymal atypical pneumonic infiltration both processes most often resolved simultaneously. Infrequently, evidence of residual pleural thickening would persist for about ten days after the pneumonia had completely cleared. However, all of the roentgenograms showed sufficient resolution to allow the patients to resume full military duties.

#### DISCUSSION

It was found necessary to differentiate exudate or effusion in the lower halves of the interlobar fissures from (1) middle lobe pneumonia and/or atelectasis, (2) involvement of the lower anteromedial portion of the left upper lobe adjacent to the interlobar fissure and near the heart and (3) infiltrations in the lower lobes mesially, near or behind the heart.

Middle lobe involvements resulted in roentgenographic appearances quite similar to lower interlobar fissure exudates in the frontal view (Fig. 8*A*). However, the density of the middle lobe processes was usually considerably greater and less homogeneous, and the normal lower lobe pulmonary markings were less sharply delineated within it. Definite exclusion was obtained only on the lateral view (Fig. 8*B*). In this view the band-like or fusiform shadow of the interlobar process could be differentiated with ease from the characteristic

triangular appearance of the opacified, involved middle lobe. The base of the triangle, lying against the anterior chest wall, was very much larger and extended considerably higher than the lower anterior end of the band-like opacity of the thickened interlobar fissure. The upper margin of the density of the involved middle lobe was almost horizontal, being limited by the short fissure; whereas the band-like density of the thickened long fissure extended obliquely upward and posteriorly at an angle approximating  $45^{\circ}$ .

Pneumonia located in the lower medial portions of the left upper lobe adjacent to the long fissure and near the heart also required exclusion (Fig. 8*C*). In these cases, the opacity, while occupying the lower portion of the lung field medially and blurring the cardiac border, did not extend down to the diaphragm. The margin of the density was rather sharply delineated and assumed an arc-like curve, convexity downward, with the lowest portion of the arc being adjacent to the left cardiac border. A clear triangular space of uninvolved pulmonary tissue was observed between the mesial aspect of the opacity and the diaphragm. Additional aid in differentiation was obtained from the lateral view (Fig. 8*D*). The broad area of radiodensity due to the upper lobe involvement was easily differentiated from the band-like density of the thickened fissure. The lower margin of the pneumonic process was extremely sharp, being limited by the long fissure, and formed an acute angle with the anterior end of the diaphragm. The characteristic irregular knob-like opacity of interlobar fissure involvement, clouding the angle between the lower long fissure and the diaphragm, was absent.

Lower lobe infiltrations near the heart occasionally offered difficulty in differentiation (Fig. 9*A*). However, careful observation revealed that the opacity of the cardiophrenic angle was not homogeneous. Instead, it consisted of distinctly increased pulmonary markings, with or without small patchy pneumonic infiltrations. Definite

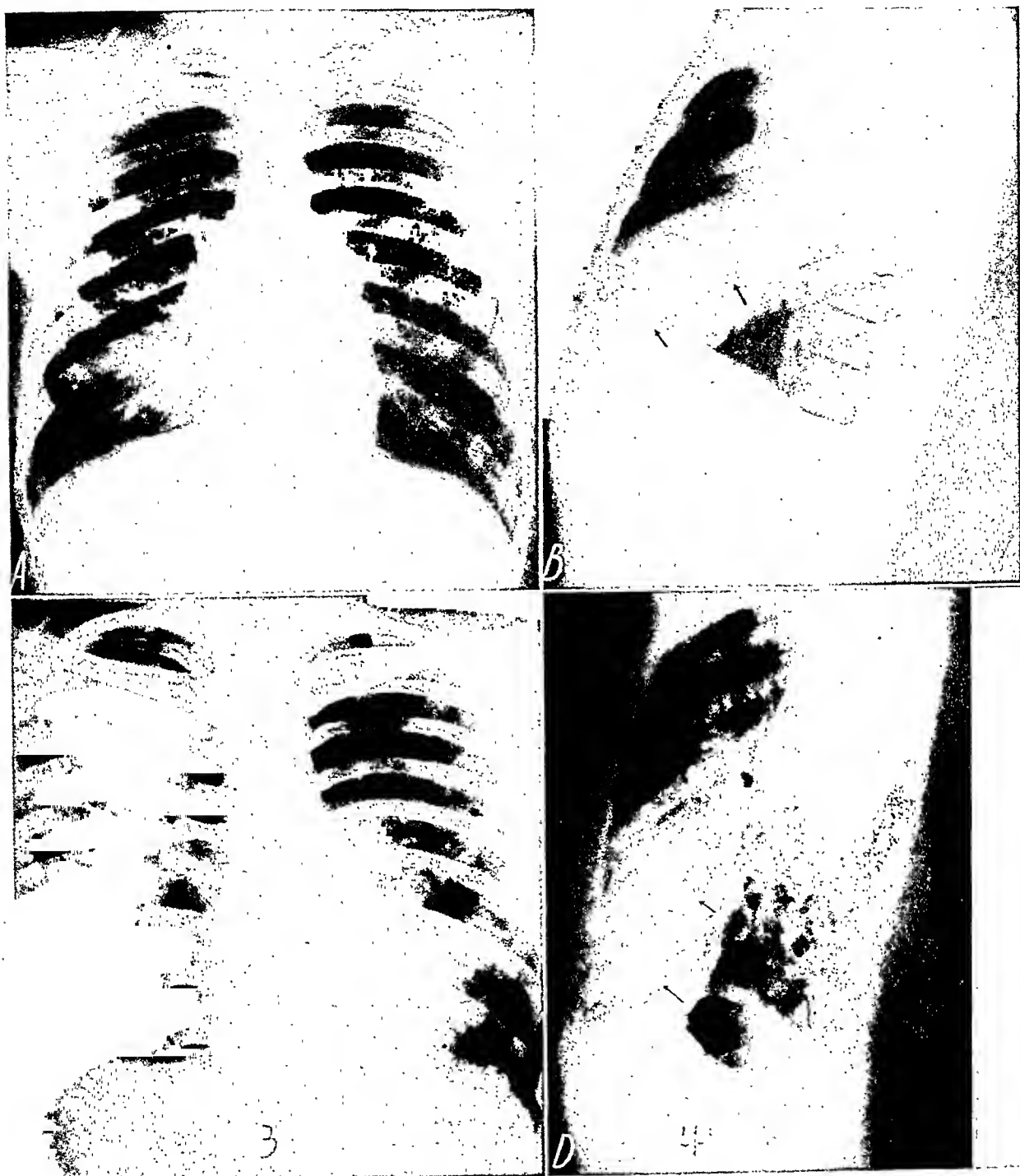


FIG. 8. *A*, pneumonia in right middle lobe. Frontal view. *B*, right lateral view. Same case as *A*. Note the triangular shape of the opacified middle lobe. *C*, pneumonia in lower mesial portion of left upper lobe adjacent to the fissure. Frontal view. *D*, left lateral view. Same case as *C*. Large area of infiltration in the lower anterior portion of the left upper lobe is well shown.

exclusion could again be obtained from the lateral and oblique roentgenograms (Fig. 9*B* and 9*C*), which showed the location of the process in the lower lobes posteriorly and the freedom from involvement of the interlobar fissure.

Inflammatory processes in the pleura,

particularly of the interlobar fissures, during the course of primary atypical pneumonia have occurred in our series of cases in a much higher degree than has been reported by practically all other observers. This may have been due, in considerable extent, to the frequent employment of



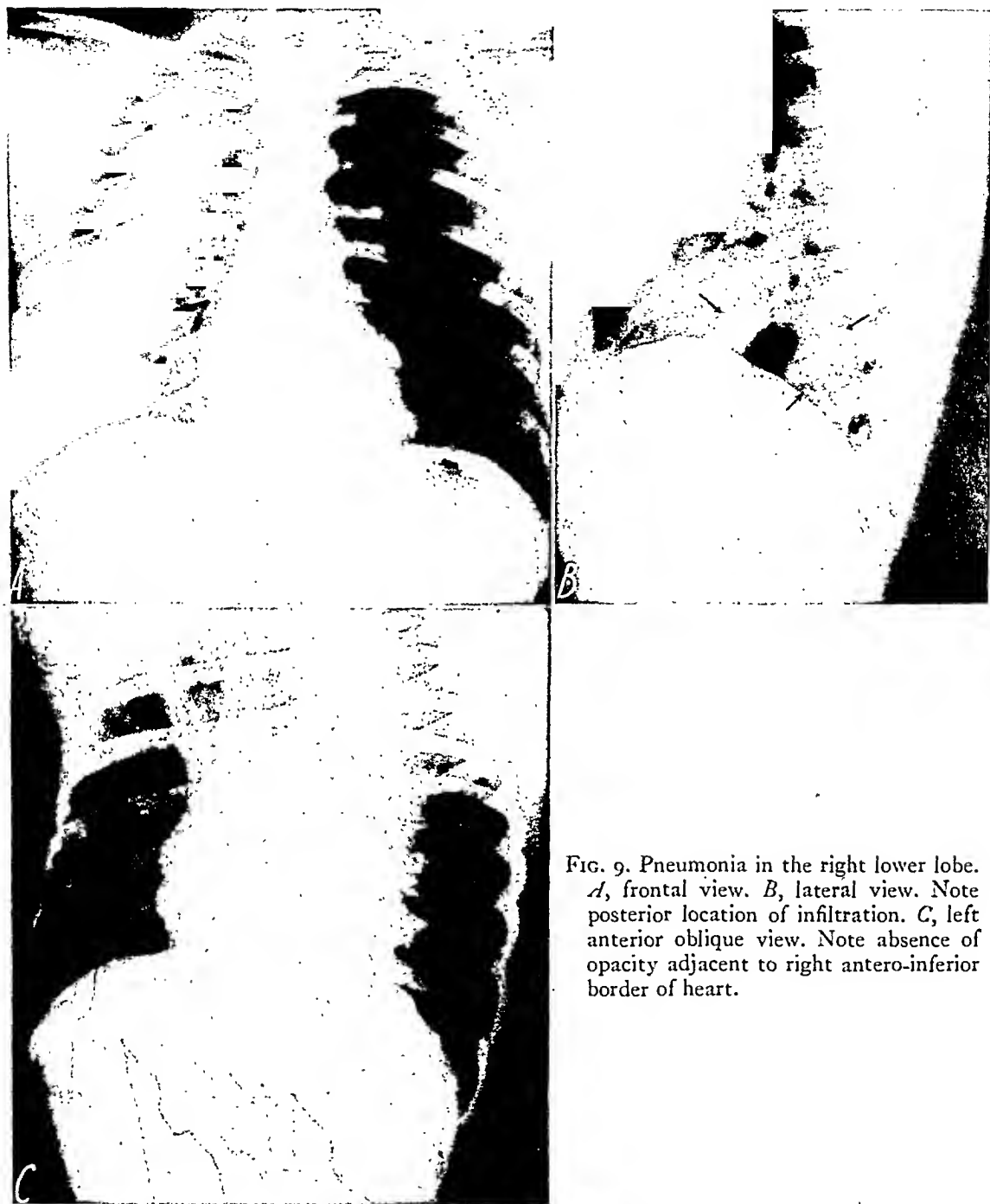


FIG. 9. Pneumonia in the right lower lobe. *A*, frontal view. *B*, lateral view. Note posterior location of infiltration. *C*, left anterior oblique view. Note absence of opacity adjacent to right antero-inferior border of heart.

lateral and oblique views in practically all cases of pneumonia, and especially whenever there was a possibility of interlobar fissure involvement. In several of the patients the definite diagnosis of interlobar thickening could be made only after additional roentgenographic examinations had been made. It was of interest that in several of the publications on atypical pneumonia

containing no mention of pleural involvement, frontal roentgenograms presented as illustrations of lower lobe pneumonia had the appearance we have found characteristic of exudative pleuritis of the inferior portions of the interlobar fissures. Unfortunately, in these cases, lateral views were not shown and no mention was made of examinations having been performed in

the various positions. On the other hand, oblique and lateral views were employed by other investigators and found of considerable value.<sup>2,8,16,18,27,33,35</sup> Cryslér,<sup>4</sup> who reported a similar, comparatively high incidence of pleural involvement with atypical pneumonia (22 out of 178 cases), stressed the importance of the lateral projection in the diagnosis of pleural thickening.

The occurrence of an associated pleuritic inflammatory process was found to have no apparent influence on the clinical course of the disease in these ambulatory cases. Of the 21 patients with pleural involvement 20 had symptoms and signs no more severe than the remaining 123 cases with atypical pneumonia who showed no evidence of involvement. The only moderately severe case clinically was the patient with an extensive effusion in the general pleural space. There was no mortality or severe complication in this series.

#### CONCLUSIONS

1. Of 144 ambulatory cases of primary atypical pneumonia 21 (14.5 per cent) demonstrated definite roentgenographic evidence of involvement of the pleura. The majority of these cases showed thickening of the lower ends of the long fissures probably due to exudate. Roentgenographic re-examination revealed that these abnormal pleural shadows disappeared usually in two to four weeks, a short time after the complete clinical recovery of the patients.

2. The distinctive roentgenographic features of these cases are described. Differential diagnosis is discussed and the importance of lateral and oblique views is stressed.

3. The clinical course of the patients appeared to be essentially the same as corresponding cases of atypical pneumonia without pleural involvement.

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## AN EVALUATION OF TELEROENTGENOGRAPHIC MENSURATION AND CARDIAC ROENTGENOSCOPY IN THE DIAGNOSIS OF EARLY MITRAL VALVE DISEASE\*

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EARLY roentgenologic recognition of cardiac enlargement is desirable because a definite diagnosis of heart disease may depend on this information. To achieve this, Hodges and Eyster presented charts correlating the cardiac surface area<sup>5</sup> and transverse diameter<sup>4</sup> with patients' heights and weights. In 1939, Ungerleider and Clark<sup>11</sup> published a prediction chart for the transverse diameter of the heart in relation to normal patients' heights and weights based on teleroentgenographic mensuration. Ungerleider and Gubner<sup>13</sup> later presented a nomogram to determine the actual cardiac surface area from teleroentgenograms for comparison with predicted average cardiac surface areas established in relation to normal individuals' heights and weights. Ungerleider, Duhigg and Gubner<sup>12</sup> stated that teleroentgenograms were the most practical method of determining heart size, but clearly indicated that the best way to determine chamber enlargement was by means of cardiac roentgenoscopy.

Newcomer and Newcomer<sup>7</sup> reported that cardiac enlargement could be estimated by computing the ratio of the heart rectangle to the lung rectangle as measured teleroentgenologically. Patients' heights and weights were not taken into consideration, although allowance was made for the various types of hearts. Ratios over 27 per cent were believed to represent definite enlargement.

Ungerleider and Gubner<sup>13</sup> agreed that this was a reliable method when information as to heights and weights was lacking. They also remarked that under such conditions cardiac enlargement might be estimated from the relationship of the lower

left cardiac border to the mid-clavicular line.<sup>2</sup> The unreliable nature of the latter procedure was indicated by them later in a case reported in 1943 in which the apex was within the mid-clavicular line despite obvious cardiac enlargement.<sup>12</sup>

Comeau and White<sup>1</sup> ascribed some value to the cardiothoracic ratio in following individual cases. Nevertheless, they recommended its replacement by prediction tables, which they regarded as more reliable and equally simple. They stressed the fact that although a majority of patients with significant cardiac enlargement could be defined by mensuration, there was no reliable method of determining how many people with slight or moderate cardiac enlargement were included within the established normal limits.

Levy, Stroud and White<sup>6</sup> reported that the most frequent cause for the rejection of men for military service was rheumatic mitral valve disease. Roentgenologically, they found the Hodges and Eyster formula inadequate, and they concluded that height and weight alone did not indicate important variations in normal body build, and that no criteria yet introduced adequately covered the range of the normal heart.

The first recognizable change in the size of the heart due to mitral valve disease is enlargement of the left auricle which may occur before the other chambers are affected. Sosman<sup>10</sup> considered such dilatation indicative of mitral stenosis even in the absence of typical auscultatory findings. According to Parkinson<sup>8</sup> the demonstration of an enlarged left auricle is second in importance only to the characteristic murmurs in the diagnosis of mitral stenosis.

\* From the Radiologic Service of M. G. Wasch, M.D., The Jewish Hospital of Brooklyn, Brooklyn, N. Y.

TABLE I  
TELEROENTGENOGRAPHIC MENSURATION AND CARDIAC FLUOROSCOPY IN DIAGNOSIS OF EARLY MITRAL VALVE DISEASE

Case No.	Age (yr.) and Sex	Clinical Diagnosis	Murmurs	Actual Transverse Diameter of Heart mm.	Predicted Transverse Diameter from Chart mm.	Predicted Transverse Diameter from Nomogram mm.	Actual Surface Area from Nomogram sq. cm.	Predicted Surface Area from Nomogram sq. cm.
1	10 F	Mitral stenosis and insufficiency	Short presystolic, long loud systolic at apex	108	106	106	82	88
2	12 M	Mitral insufficiency	Long, loud apical systolic transmitted to axilla	115	110	117	101	100
3	12 F	1937—functional murmur 1939—murmur louder, transmitted to walls 1942—mitral insufficiency	Short apical systolic  Persistent loud systolic at apex, transmitted to axilla	  108	  121	  121	  93	  104
4	12 M	Mitral insufficiency	Loud, high pitched apical systolic transmitted to axilla	114	114	112	94	96
5	13 F	Mitral insufficiency	Systolic at apex transmitted to axilla; ? diastolic; definite diastolic heard two years later	118 (1937) 108 (1940)	121 (1937) 125 (1940)	121 (1937) 125 (1940)	101 (1937) 104 (1940)	105 (1937) 108 (1940)
6	16 M	Mitral insufficiency	Rough, loud systolic at apex transmitted to axilla	120	127	127	128	118
7	17 F	Mitral stenosis and insufficiency	Systolic and diastolic at the apex	120	120	120	106	121
8	17 M	Mitral stenosis and insufficiency; aortic insufficiency	Systolic and diastolic at apex, diastolic along left sternal border	112	Height and weight not available			
9	17 F	? Mitral insufficiency	Systolic at apex and pneumonic area; ? apical diastolic	115	Height and weight not available			
10	17 M	Mitral insufficiency and stenosis	Long blowing apical systolic and diastolic	122	119	119	120	108
11	18 M	1927—mitral stenosis and insufficiency 1938—functional	Rough blowing apical systolic and diastolic Soft apical systolic, not transmitted	110	117	117	110	110
12	18 F	Subacute bacterial endocarditis; mitral insufficiency	Loud harsh systolic at apex, no diastolic	103	117	117	109	108
13	20 F	Mitral stenosis and insufficiency	Systolic and diastolic at apex	105	Height and weight not available			
14	21 F	Mitral stenosis	Short basal systolic, long apical diastolic	127	133	134	121	121
15	22 F	Ulcerative colitis, mitral stenosis and insufficiency	Rough systolic and short diastolic at apex	103	Height and weight not available			
16	22 F	Mitral stenosis and insufficiency	Systolic and presystolic at apex	110	121	122	120	108
17	23 M	Mitral stenosis and insufficiency	Systolic and presystolic at apex	137	142	142	138	130
18	23 F	Possible mitral insufficiency	Systolic at apex	122	118	118	110	112
19	25 M	Mitral stenosis and insufficiency	Systolic and diastolic at apex	143	Height and weight not available			

TABLE I—Continued

Heart Rectangle Lung Rectangle Ratio Per Cent	Cardiac Enlargement from Measurements	Enlarged Left Auricle	Change in Heart Contour	Comment		
				History of Rheumatic Fever	Duration of Known Heart Disease	Period of Observation
25	None	++	None	Yes	6 yr.	
27	None	++	None	Yes	6 yr.	4 yr.; no change
25	None	++	None	No	6 yr. (?)	5 yr.
27	None	++	None	Yes	6 yr.	Death from subacute bacterial endocarditis; autopsy revealed slight mitral insufficiency
26 (1937) 24 (1940)	None None	++ ++	None	Yes	3 yr.	3 yr.
22	? None	++	None	Yes	5 yr.	2 yr.
27	None	++	None	No	Unknown	—
25		++	None	Yes	7 yr.	—
26		++	Prominent pulmonary artery	No	Unknown	—
27	None	++	None	No	7 yr.	2 yr.
25	None	++	None	?	11 yr. (?)	11 yr.
18	None	++	None	?	10 yr.	Dead. Autopsy revealed mitral stenosis and dilated left auricle
26		++	None	?	9 yr.	9 yr.; murmurs persisted
26	None	++	None	Yes	7 yr.	—
23		++	None	Yes	8 yr.	Autopsy—mitral endocarditis with dilated left auricle
25	None	++	None	Yes	15 yr.	5 yr.
23	None	++	Straightened left border	?	6 yr.	6 yr.
25	None	++	None	?	?	24 yr.
23		++	None	None	Unknown	—

TABLE 1—*Continued*  
TELEORIENTOGENOGRAPHIC MENSURATION AND CARDIAC FLUOROSCOPY IN DIAGNOSIS OF EARLY MITRAL VALVE DISEASE

Case No.	Age (yr.) and Sex	Clinical Diagnosis	Murmurs	Actual Transverse Diameter of Heart mm.	Predicted Transverse Diameter from Chart mm.	Predicted Transverse Diameter from Nomogram mm.	Actual Surface Area from Nomogram cm.	Predicted Surface Area from Nomogram sq. cm.
20	23 F	Mitral stenosis and insufficiency	Systolic and diastolic at apex	130	Height not available			
21	25 F	Mitral stenosis and insufficiency	Systolic and presystolic at apex	141	137	137	102	108
22	26 F	Mitral stenosis and insufficiency	Systolic and diastolic at apex	110	Height and weight not available			
23	26 F	Mitral stenosis and insufficiency	Rough loud presystolic	110	Height not available			
24	26 F	Mitral stenosis and insufficiency	Rough systolic and presystolic at apex	124	122	122	98	110
25	26 F	Mitral stenosis and insufficiency	Rough systolic and presystolic at apex transmitted to axilla	132	117	117	106	104
26	28 F	Possible heart disease	Systolic at apex	117	117	117	104	98
27	29 F	Possible heart disease	Systolic at apex	135	131	130	98	102
28	33 M	Mitral stenosis and insufficiency	Systolic and diastolic at apex	112	Height and weight not available			
29	33 M	Mitral insufficiency	Presystolic at apex	115	Height not available			
30	34 F	Mitral stenosis and insufficiency	Systolic and presystolic at apex	110	Height not available			
31	34 F	Mitral stenosis and insufficiency	Systolic and diastolic at apex	114	113	113	101	116
32	39 F	Mitral stenosis and insufficiency	Loud apical diastolic with snapping first sound	113	128	128	112	105
33	39 F	Mitral stenosis and insufficiency	Systolic and diastolic at apex	110	Height and weight not available			
34	41 F	Mitral stenosis and insufficiency	Loud presystolic and systolic at apex	113	Height and weight not available			
35	42 F	Mitral stenosis	Rough low pitched mid-diastolic and presystolic	120	135	140	104	94
36	42 F	Heart disease	Short systolic at apex transmitted to axilla	138	133	133	122	122
37	42 F	Mitral stenosis and insufficiency; aortic insufficiency	Loud systolic and rough diastolic at apex, loud systolic at aortic	136	122	123	114	103
38	49 F	Mitral stenosis and insufficiency; aortic insufficiency	Loud rough apical systolic and diastolic, basal systolic	115	Height and weight not available			
39	54 F	Mitral stenosis and insufficiency; aortic insufficiency	Systolic and diastolic at apex, basal systolic	112	Highest and weight not available			
40	56 F	Mitral stenosis and insufficiency	Long apical diastolic	127	125	123	100	112



TABLE I—Continued

Heart Rectangle Lung Rectangle Ratio  Per Cent	Cardiac Enlargement from Measurements	Enlarged Left Auricle	Change in Heart Contour	Comment		
				History of Rheumatic Fever	Duration of Known Heart Disease	Period of Observation
23		++	None	Yes	11 yr.	2 yr.
27	None	++	None	Yes	18 yr.	5 yr.
24		++	None	No	4 yr.	4 yr.
25		++	None	?	2 yr.	—
23	None	++	None	Yes	4 yr.	4 yr.
22	None	++	None	No	?	1 yr.
25	None	++	None	No	?	—
26	None	++	None	No	9 yr.	—
23		++	None	Yes	3 yr.	2 yr.
22		++	None	No	Unknown	—
25		++	None	No	5 yr.	5 yr.
26	None	++	None	Yes	More than 20 yr.	—
24	None	++	None	Yes	More than 20 yr.	—
25	None	++	None	Yes	20 yr.	—
23		++	None	Yes	More than 20 yr.	—
21	None	++	None	None	Unknown	3 yr.
29	? From $\frac{\text{heart}}{\text{lung}}$ rectangle	++	None	Yes	Unknown	—
27	? From predicted transverse diameter	++	Prominent left border	?	Unknown	3 yr.
25		++	Prominent left border	Yes	18 yr.	—
25		++	None	Yes	More than 30 yr.	—
27	? from surface area nomogram	+++	Prominent left border	Yes	21 yr.	Autopsy—mitral stenosis with large ball-valve thrombus in left auricle.

Thus far the criteria most frequently used for estimating cardiac enlargement are based on teleroentgenographic mensuration. These do not take into consideration the fact that posterior enlargement of the left auricle may occur without altering the frontal silhouette of the heart. Teleroentgenographic mensuration was found to be of little value in the diagnosis of early mitral valve disease in children, but demonstration of enlargement of the left auricle in the right anterior oblique projection was very important, particularly in the absence of classical murmurs.<sup>3</sup>

In this communication 40 patients with early but indisputable mitral valve disease are reviewed from the roentgenologic viewpoint. The various methods of teleroentgenographic mensuration proposed by Ungerleider and Clark and Ungerleider and Gubner were used and the findings compared with roentgenologic observations for left auricular dilatation. The heart rectangle:lung rectangle ratios were calculated and the relationship of the apex of the heart to the left mid-clavicular line was determined.

#### MATERIAL AND FINDINGS

There were 9 men and 31 women from ten to fifty-four years old in this group. All but 4 were ambulatory at the time of roentgenologic examination. Each patient was examined roentgenoscopically, by means of posteroanterior teleroentgenograms and right anterior oblique views made after swallowing a bolus of barium paste.

The barium paste was made by adding a heaping tablespoon of chocolate barium preparation to a quarter of a glass of water and stirring vigorously until a thick, smooth creamy consistency was obtained. The patient was given a swallow of paste after being placed in approximately the correct position, and roentgenoscopic observations were made during suspended respiration and deep inspiration. Roentgenograms were made at the end of a moderate inspiration, permitting a few seconds to elapse after the patient had swallowed

his mouthful of barium paste. For survey purposes an angle of from 75 to 85 degrees in the right anterior oblique position should be adequate.

The normal right anterior oblique roentgenogram of the esophagus presents a straight opaque line posterior to the cardiac silhouette. Early left auricular enlargement usually results in an indentation into the anterior aspect of the barium column at the proper level. This is visible only in the right anterior oblique position approximately in the middle third of the esophagus because the degree of enlargement at that time is usually insufficient to shift the esophagus from left to right laterally.

Occasionally patients were encountered in whom there was a gentle sloping arc of displacement of the barium-filled esophagus. These were considered to be within normal limits. Difficulty also arose in some patients with tortuous and dilated aortas, in whom the esophagus was drawn to the left and posteriorly. In these the right anterior oblique projection of the esophagus may simulate enlargement of the left auricle.<sup>9</sup> Enlargement of the left auricle was diagnosed only when there was a localized indentation at the proper level which persisted during deep inspiration.

Twenty-one patients had known histories of rheumatic fever and 7 had histories suspicious of rheumatic fever. The duration of known heart disease varied from a few months to over twenty years. Six were followed for two years, 10 for three to five years, 2 from six to ten years and 1 for eleven years. Four patients came to post-mortem examination.

Twenty-nine patients had characteristic apical systolic and diastolic murmurs, and 11 had loud apical systolic murmurs transmitted to the axilla. In most of the patients who were followed the auscultatory signs of mitral valve disease persisted unchanged or increased in intensity. In 4 there was recession of the murmurs so that at one time or another the clinical diagnosis had been changed to functional heart murmurs. There is little doubt that the mitral lesions

in these individuals were persistent even though the clinical signs varied.

Electrocardiographic examinations were available in 22 patients. Prolonged auriculoventricular conduction times were present in 2, and 2 others had auricular fibrillation. All the remaining patients had normal electrocardiographic findings.

All 40 patients had visibly enlarged left auricles as indicated by posterior deviation

both as to predicted and actual transverse cardiac diameters and predicted and actual cardiac surface areas in all but 2 patients (Cases 37 and 40).

The heart rectangle:lung rectangle ratio did not exceed 27 per cent nor did the apex of the heart protrude beyond the mid-clavicular line in any of the patients.

The 4 patients who came to postmortem examination are reported in further detail.

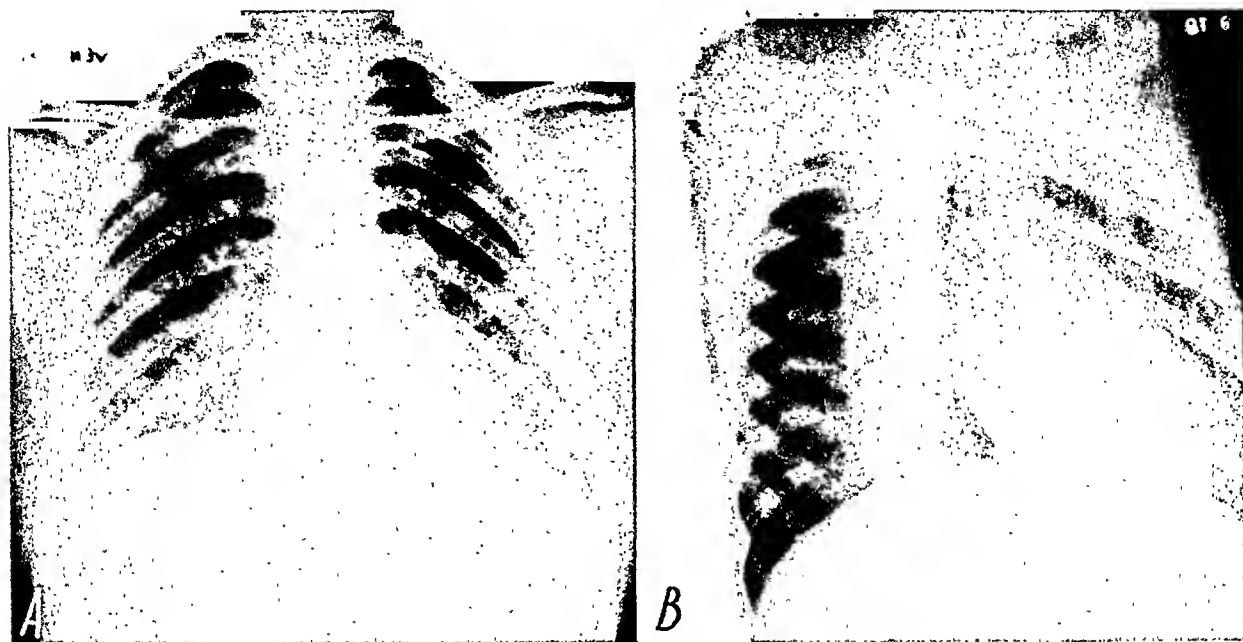


FIG. 1. Case 4. *A*, teleroentgenogram of a twelve year old boy 5 feet tall weighing 108 pounds. Actual transverse cardiac diameter 112 mm., predicted transverse diameter 114 mm. Predicted surface area 96 sq. cm., actual surface area 94 sq. cm. Heart rectangle:lung rectangle ratio 27 per cent. *B*, right anterior oblique roentgenogram of the esophagus showing slight but definite posterior displacement indicative of left auricular dilatation. See text for details of history.

of the barium-filled esophagus in the right anterior oblique projection. No visible deviation of the esophagus was apparent in the posteroanterior view. There were no other signs of left auricular dilatation. The position of the bronchi was unchanged and the left auricle did not appear on the right cardiac border. Straightening of the second left cardiac border occurred occasionally, but the characteristic "mitral heart" deformity was conspicuous by its absence. In 3 patients slight left ventricular enlargement was diagnosed.

The heights and weights of 25 patients were available. Teleroentgenographic mensuration of these was within normal limits

#### REPORT OF CASES

CASE 4. I. B., a boy, aged twelve, had rheumatic fever at the age of six years. Cardiac involvement was diagnosed at that time. He was symptom free thereafter and was observed for the next six years in the out-patient department. He was active and developed normally. A loud blowing apical systolic murmur transmitted to the axilla was present at all examinations.

Joint pains recurred for three weeks six months before admission to the Hospital. He complained of periumbilical cramps for three weeks and his temperature rose to 103° F. Physical examination revealed a high pitched apical systolic murmur transmitted to the axilla. The second pulmonic sound was accentuated. A few

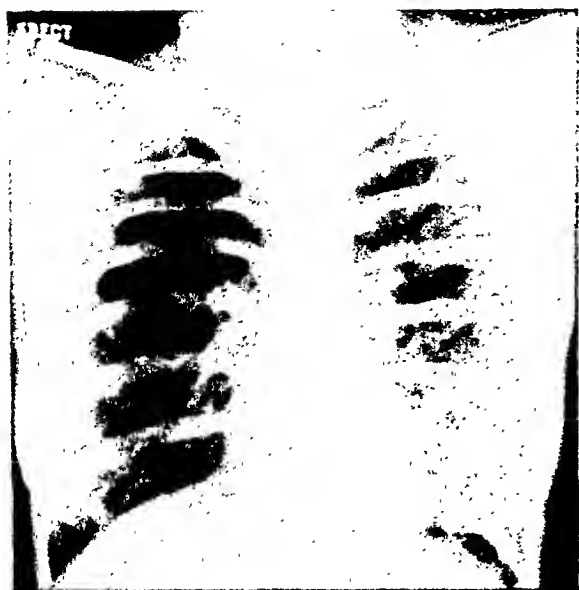


FIG. 2. Case 12. Teleroentgenogram of an eighteen year old girl 65 inches tall weighing 122 pounds. Actual transverse cardiac diameter 103 mm., predicted transverse diameter 117 mm. Predicted surface area 108 sq. cm., actual surface area 109 sq. cm. Heart rectangle: lung rectangle ratio 18 per cent. Roentgenoscopic examination showed definite left auricular enlargement. See text for details of history.

days later petechiae were found in his conjunctivae and over his hands and feet. His spleen was not palpable. Blood cultures were positive for *Streptococcus viridans*. Electrocardiographic examination was negative.

At the time of roentgenologic examination he was 60 inches tall and weighed 108 pounds. A teleroentgenogram did not show any gross cardiac enlargement. Roentgenoscopically early left auricular dilatation and slight left ventricular enlargement posteriorly was noted. The predicted transverse cardiac diameter was 114 mm., the actual transverse diameter was 112 mm. The predicted cardiac surface area was 96 sq. cm., the actual surface area was 94 sq. cm. The heart rectangle: lung rectangle ratio was 27 per cent. The apex was within the mid-clavicular line.

At autopsy the heart weighed 350 grams. The left ventricle was 1.0 cm. thick, the right ventricle 0.25 cm. thick. The circumference of the mitral ring was 11 cm., that of the tricuspid ring 10 cm. The aortic and pulmonic rings measured 6.5 cm. The mitral valve was distorted, mitral stenosis and insufficiency being evident. Vegetations were seen on the leaflets

extending on to the left auricular endocardium. The left ventricle and left auricle were hypertrophied and dilated. Microscopically there was evidence of active rheumatic carditis.

CASE 12. M. W., a girl, aged eighteen, was known to have had rheumatic fever at the age of two and a half years. Since then she had been able to indulge in the usual pastimes and perform the usual tasks of growing girls. Physical examination in 1941 revealed a loud blowing apical systolic murmur transmitted to the axilla. This was unchanged in March and May, 1942.

She was admitted to the Hospital in May, 1942, because of fever, chills and embolic phenomena. Repeated blood cultures were positive for *Streptococcus viridans*.

Teleroentgenographic examination of her chest in March, May, August and September, 1942, showed a normal heart silhouette. Cardiac roentgenoscopy during September, 1942, revealed definite posterior displacement of the barium-filled esophagus indicative of left auricular dilatation.

At the time of roentgenologic examination she weighed 122 pounds and was 65 inches tall. The predicted transverse cardiac diameter was 117 mm., the actual transverse diameter 103

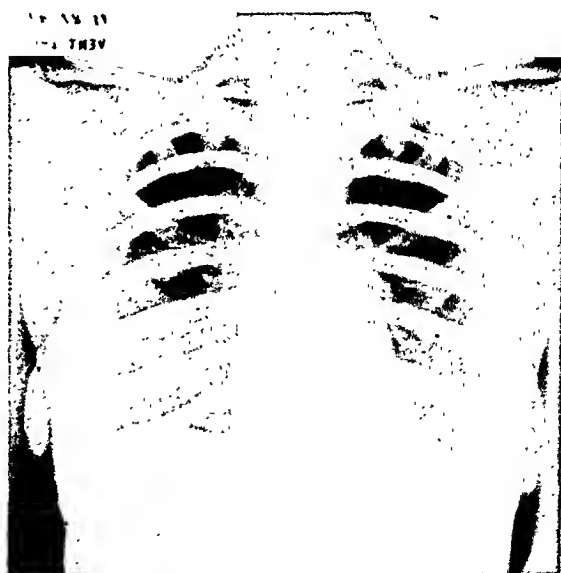


FIG. 3. Case 15. Teleroentgenogram of a twenty-two year old woman, height and weight unknown. Heart rectangle: lung rectangle ratio 23 per cent. No change in heart silhouette, but definite left auricular dilatation was found at postmortem examination.

mm. The predicted cardiac surface area was 108 sq. cm., the actual surface area 109 sq. cm. The heart rectangle: lung rectangle ratio was 18 per cent. The apex was within the mid-clavicular line.

At autopsy her heart weighed 140 grams. The left ventricle was 1.0 cm. thick, the right ventricle 0.3 cm. thick. The left auricle was dilated. The mitral valve was stenotic and fresh and old vegetations were present over the entire valve. The chordae tendineae were shortened,

Teleroentgenographic examination of her chest showed no change in the appearance of the heart shadow. The heart rectangle: lung rectangle ratio was 23 per cent. The apex was within the mid-clavicular line. Her height and weight were not available.

At autopsy her heart weighed 190 grams. The left auricle was dilated, the heart otherwise was not enlarged. The mitral leaflets were thickened; vascularized and healed thrombotic masses were present at their tips. Mitral insuffi-

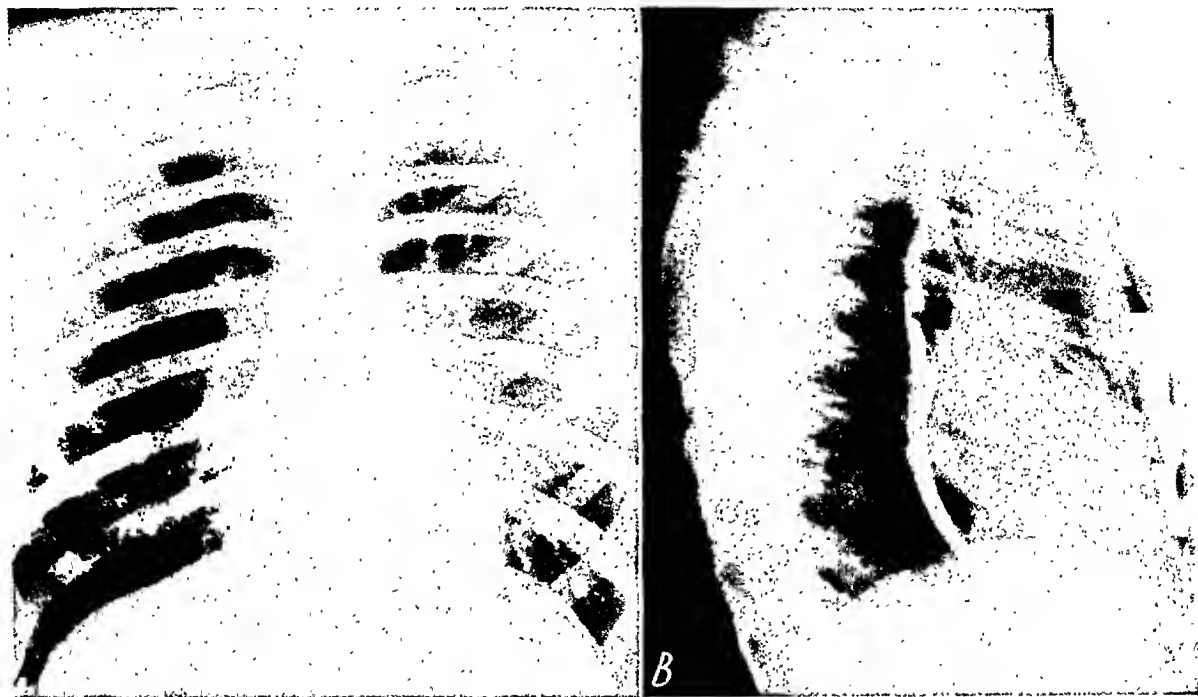


FIG. 4. Case 6. *A*, teleroentgenogram of a sixteen year old boy, 67 inches tall weighing 150 pounds. Actual transverse diameter 120 mm., predicted transverse diameter 127 mm. Predicted surface area 118 sq. cm., actual surface area 128 sq. cm. Heart rectangle:lung rectangle ratio 22 per cent. Rough loud apical systolic murmur transmitted to the axilla. *B*, right anterior oblique roentgenogram of the esophagus showing posterior deviation indicative of left auricular enlargement.

thickened and fused. The other heart chambers were normal.

CASE 15. B. S., a female, aged twenty-two, had diarrhea with blood and mucous rectal discharges for six months before admission to the Hospital. Proctoscopic and roentgenographic examinations confirmed the diagnosis of acute ulcerative colitis, and a biopsy revealed chronic and acute proctitis.

Her cardiac condition was discovered eight years ago during her first attack of rheumatic fever. There had been no symptoms referable to her cardiac or rheumatic status since then. Characteristic systolic and diastolic murmurs were audible at the apex.

ciency was present. The aortic valve cusps were thickened, but the valve was competent.

CASE 40. A. S., a female, aged fifty-six, had rheumatic fever thirty-six years ago and cardiac involvement was diagnosed at that time. Nevertheless she had been able to lead an active life.

For two years before admission to the Hospital she had dyspnea on exertion which responded to digitalization and diuretics. Auricular fibrillation had been present from that time on.

She was admitted because of right upper quadrant pain, distention, gaseous eructations and constipation. On physical examination systolic and diastolic murmurs characteristic of



FIG. 5. Case 35. *A*, teleroentgenogram of a forty-two year old woman 61 inches tall weighing 178 pounds. Actual transverse cardiac diameter 120 mm., predicted transverse diameter 135 mm. Actual surface area 104 sq. cm., predicted surface area 94 sq. cm. Heart rectangle:lung rectangle ratio 21 per cent. Rough low-pitched mid-diastolic and presystolic apical murmurs. *B*, right anterior oblique roentgenogram of the esophagus showing posterior deviation of the barium-filled esophagus indicative of left auricular enlargement.



FIG. 6. Case 40. *A*, teleroentgenogram of a fifty-six year old woman 61 inches tall weighing 122 pounds. Actual transverse cardiac diameter 127 mm., predicted transverse diameter 123 mm. Actual surface area 132 sq. cm., predicted surface area 100 sq. cm. indicating cardiac enlargement. Heart rectangle:lung rectangle ratio 27 per cent. *B*, right anterior oblique roentgenogram of the esophagus showing deep indentation indicative of considerable left auricular dilatation.

mitral disease were heard. There was a moderate secondary anemia. Occult blood was found in her stool.

Roentgenologic examination of the gastrointestinal tract revealed a malignant condition of the pylorus.

A chest teleroentgenogram showed straightening of the second left heart border. There was considerable dilatation of the left auricle posteriorly. Slight enlargement of the left ventricle was present.

At the time of roentgenologic examination she weighed 125 pounds and was 61 inches tall. The predicted transverse cardiac diameter was 125 mm., the actual transverse diameter 127 mm. The predicted cardiac surface area was 100 sq. cm., the actual surface area was 132 sq. cm., indicating cardiac enlargement. The heart rectangle: lung rectangle ratio was 27 per cent.

She died after subtotal gastrectomy. At autopsy her heart weighed 430 grams. The left ventricle was 1.2 cm. thick, the right ventricle 1.0 cm. thick. The left auricle was considerably dilated and contained a large friable gray-red thrombus measuring 8 by 5 by 3 cm. The mitral orifice was small and stenotic. The papillary muscles were shortened, thickened and fused. The lungs were normal. On reviewing the roentgenograms after postmortem examination a crescentic line could be identified just within the right heart border corresponding to the location of the intra-auricular thrombus.

#### SUMMARY

1. In the early stages of mitral valve disease the heart may retain its normal size and contour in the frontal projection. Enlargement of the left auricle may be the only chamber affected, and this may be visible only in the right anterior oblique projection. If teleroentgenograms alone are used for roentgen examination in doubtful cases avoidable errors may occur.

2. Prediction tables based on patients' heights and weights, the heart rectangle: lung rectangle ratio, and the relationship of the apex to the left mid-clavicular line did not prove reliable in the diagnosis of early mitral valve disease in the group of patients reported here.

3. Patients with suspicious rheumatic histories or apical murmurs should be investigated routinely for left auricular en-

largement. A diagnosis of a functional heart murmur should not be made in the presence of an enlarged left auricle.

4. As shown by two patients who came to postmortem examination mitral valve disease may exist for a long time without increase in the size of the heart other than left auricular dilatation.

5. As shown by the other two patients who came to postmortem examination ventricular hypertrophy may exist without being definitely identified by means of teleroentgenographic mensuration.

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# ELONGATION AND TORTUOSITY OF THE DESCENDING AORTA IN A CASE OF RIGHT AORTIC ARCH, SIMULATING A RIGHT-SIDED PULSATING MEDIASTINAL MASS

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A WHITE farmer, aged fifty-eight, presenting the history of chronic duodenal ulcer, appeared for gastrointestinal examination. He has had some shortness of breath on exertion since childhood. No other history was elicited with reference to the cardiovascular system. The remainder of his history was not relevant. He had never had a roentgen examination of the chest. Later on, because of some unusual roentgen findings, on physical examination a right-sided paravertebral dullness was percussed. On auscultation of the heart region, no murmurs or bruit was heard; there was no thrill over the cardiac region.

On roentgenoscopic examination of the chest, preceding administration of barium, a large pulsating mass having a right convex border was seen, enlarging the heart shadow to the right

side. The right hilum could not be seen. The right border of the mass originated about 1 inch above the right diaphragm, extended into one-third of the right lung field with the peak at its convex border. The density of the shadow could not be differentiated from the heart shadow and the finding was interpreted as due to aneurysm of the ascending aorta. The rate and time of the pulsations of the right mediastinal mass coincided with the rate and time of the radial pulse. The amplitude of the pulsations was moderate.

The trachea deviated to the left at the level of the aortic arch. With the intention of judging the width of the aortic arch, a barium mixture was administered and the esophagus was found to be to the right of the aortic knob. In the right anterior oblique position the aortic arch was posterior to the visualized esophagus, a finding sufficient for the diagnosis of right aortic arch. Nevertheless, the pulsating right mediastinal mass remained unexplained and the final diagnosis was made by the aid of roentgenograms.

On the posteroanterior teleroentgenogram the region of the pulsating shadow appeared less dense than the remainder of the cardiovascular shadow. It is almost axiomatic that normal and abnormal cardiovascular shadows cast a uniform dense shadow. Moreover, by a study of the left anterior oblique view, the ascending aorta was not found dilated; there was no aneurysm of the root of the aorta. On the basis of its different shadow density, the pulsating mass was thought to be posterior to the remaining cardiovascular shadow. Further, it was observed on the left anterior oblique view that the aortic shadow cast a hairpin-like image and did not cross over toward the spine shadow in a wide arch, as it is ordinarily seen at a 60 degree rotation of the patient. The shadow of the descending aorta was not found up along the spine shadow, but recoiled toward the heart shadow and joined the left border of the heart high up,



FIG. 1. Teleroentgenogram of chest. The cardiovascular shadow is enlarged on the right side by a pulsating mass constituting the right border of the cardiovascular shadow.

that is the aorta curved into the right lung field. The right anterior oblique view has shown that the aortic arch is located posterior to the esophagus.

#### DISCUSSION

The clinical significance of right aortic arch is small. It is recorded in the literature that it may cause dysphagia lusoria. In Golden's Diagnostic Roentgenology it is stated that dysphagia is not expected in this condition. In the case presented dysphagia was absent. Respiratory difficulty, due to pressure upon the trachea, is not noted to occur. However, this patient was said to have had shortness of breath since childhood. It was not likely that he had dyspnea in the circulatory sense and it is thought that pressure atrophy, even developmental deformity of the trachea, can be present, with a weak wall and a degree of partial collapse on increased respiratory ef-

the normal aorta develops. Exceptionally the aorta develops from the right fourth arch, as in our case. It is interesting to note the relationship of the innominate artery to the trachea. It is suggested that as the precursor of the innominate artery develops



FIG. 2. Right anterior oblique view of chest, showing the presence of right aortic arch.

fort. Normally the innominate and subclavian arteries develop from the fourth embryonal aortic arch on the right side. From the pair of this arch on the left side



FIG. 3. Left anterior oblique view, indicating that the descending aorta is not found in its normal anatomical location, but its course is changed. The ascending and descending aorta forms a hairpin-like shadow at a 60 degree rotation of the patient.

into the anomalous right aorta, the trachea is not only crowded to the left side, but maldevelopment should be the result of such displacement from early embryonal life.

From the viewpoint of roentgen diagnosis, elongated and tortuous right descending aorta is a rare occurrence. At routine film reading, the cardiovascular shadow will be found enlarged, the configuration suggests rounded mediastinal mass possibly aneurysm of the ascending aorta. It will be found that the shadow of the mediastinal mass has a lesser density, particularly on its periphery, than the heart shadow. In the region of the ascending aortic shadow, no clear differentiation can be seen. In the re-

gion of right auricle, the auricular border is partly seen for a short distance. On the left side, the cardiovascular angle is absent. The knob is not found in the left heart border. In the presence of a mediastinal mass, the appearance of the left heart border may be due to rotation of the heart as well as caused by a right aortic arch. The displacement of the trachea may occur with various mediastinal pathological conditions. Careful examination of the region of the displaced trachea would show that the bare shadow of the manubrium sterni is exposed on a large area. On a well centered film this, with the displaced trachea, should indicate that the left aorta is absent.

In all cases of suspected aneurysm of the ascending aorta, administration of barium is the routine procedure in order to judge the width of the aortic arch. Following this procedure it is likely that a right aortic arch will be found. This finding will indicate that the protrusion on the right side of the cardiovascular shadow is the elongated and tortuous right descending aorta. Correspondingly, on the roentgenogram taken in the left anterior oblique view, the hair-pin-like shadow formation of the ascending and descending aorta will be found. The descending aorta will not be found in its normal anatomical location along the spine shadow.



# CONGENITAL HYDRONEPHROSIS CAUSED BY A POLAR ARTERY\*

## REPORT OF A CASE

By EDMUNDO INGBER, M.D.

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THE case history which follows has not been published before because we wanted to observe the postoperative results for a sufficient length of time. It has now been more than a year since the operation and the patient has resumed his work, using a bicycle as a means of transportation.

B.S., aged thirty, unmarried, native of Santa Fe, Argentina.

Family and past history, irrelevant.

*History of Present Illness* (Dr. Ricci). The patient came for examination because of sexual impotence which had not responded to various treatments. Urinalysis showed traces of pyuria.

A roentgenogram of the urinary tract taken without contrast medium showed in the left kidney five shadows of foreign bodies with small satellites (Fig. 1).

*Ascending pyelography* after the introduction of 10 cc. thorotrast (Dr. Ricci) showed notable dilatation of the ureter with an interruption at the lower pole of the left kidney, dilatation of the kidney pelvis and enlargement of the calices. In the contrast medium could be seen the foreign bodies which were noted in the previous examination, establishing the diagnosis of these shadows as renal calculi (Fig. 2 and 3).

*Descending intravenous pyelography* (perabrodil 10 cc., Dr. Lauria), with compression of the ureters. Right kidney: Good beginning elimination at seven minutes after the injection. "Camel's back" pelvis. Moderate dilatation of the calices. At the end of twenty minutes the kidney pelvis appeared markedly dilated, the calices a little larger than normal in the lower sector, markedly constricted in the upper sector. At the end of thirty-five minutes after the intravenous injection and without compression of the

ureters the flow appeared slow, the pelvis remained dilated, in a position of median posterior rotation (Fig. 4 to 6). Left kidney: From the first moment of the examination the contrast medium collected in numerous pseudocystic cavities but without the pro-

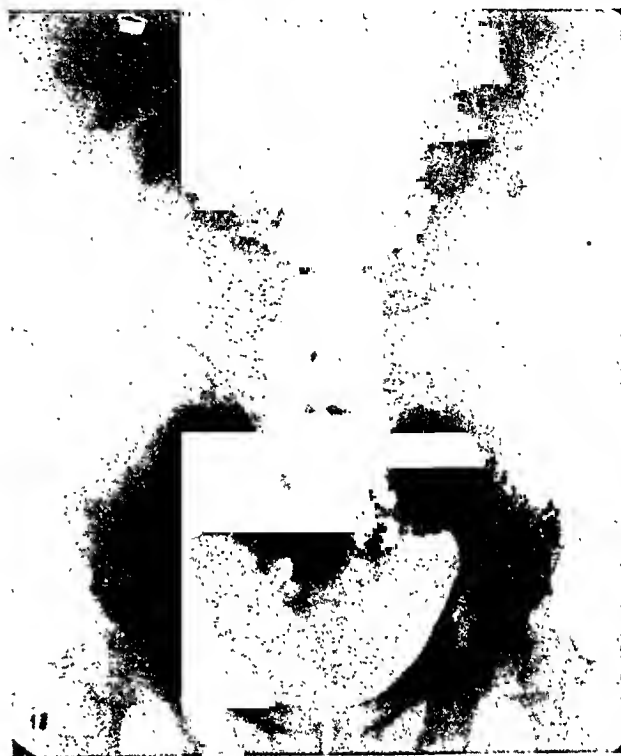


FIG. 1. Plain roentgenogram, without contrast medium.

duction of a normal form of either the pelvis or the ureter. The renal calculi could be seen through the contrast medium (Fig. 4 to 7).

*Clinico-roentgenological Diagnosis:* Congenital hydronephrosis resulting from a polar artery.

The therapeutic indication was left nephrectomy.

*Surgical Operation* (Dr. Ricci; Dr. Fari-  
as). The operation was Guyon's incision.

\* Translation made by Dr. Audrey G. Morgan, Medford, Ore.



FIG. 2. Ascending instrumental pyelogram with the use of thorotrast. Left kidney.



FIG. 3. Showing detail of Figure 2.

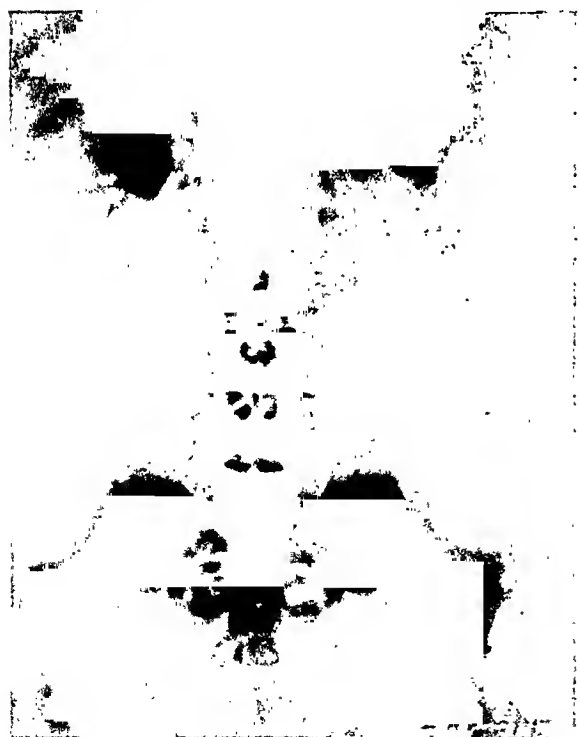


FIG. 4. Intravenous pyelogram with perabrodil. Seven minutes after injection with compression of the ureters.



FIG. 5. Same as Figure 4. Twenty minutes after injection and with compression of the ureters.



FIG. 6. Same as Figures 4 and 5. Thirty-five minutes after the injection and without compression of the ureters.



FIG. 7. Showing detail of Figure 6.



FIG. 8. Operative specimen. Left kidney. General view, external.



FIG. 9. Same as Figure 8. General view, median incision in the external border and the five calculi.

On opening the perirenal capsule the kidney was found to have only a small amount of parenchyma and a large pelvis. Nephrec-

book as classical (Fig. 8 to 10).

*Anatomo-pathological Diagnosis:* Congenital hydronephrosis from a polar artery.

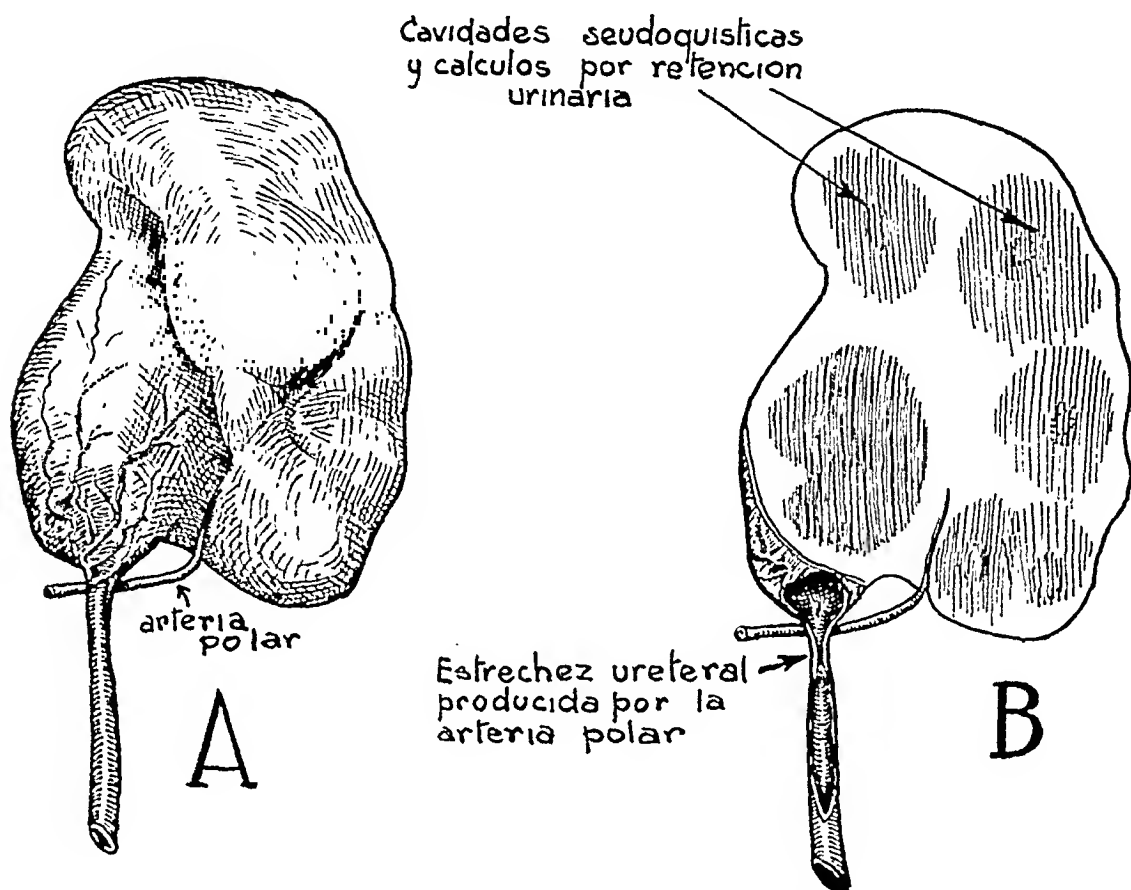


FIG. 10. Hydronephrosis from an abnormal vessel. (From Marion, G. *Traité d'urologie*. Masson et Cie, Paris, 1935, p. 468. Modified by the author with reference to the case presented.) A, Polar artery. B, Pseudocystic cavities and calculi from retention of urine. Constriction of ureter caused by polar artery.

tomy was performed and the operative specimen removed.

*Description of the Anatomical Specimen* (Dr. Ricci). Kidney with lobulated external appearance, confirming the pseudocystic images which had been seen roentgenologically. On opening the kidney, dilata-tions were found in the pelvis and calices in the interior of which the stones seen on the roentgenograms were found. The picture of the operative specimen was almost identical with that shown by Marion in his text-

The patient was discharged ten days after operation on the way to perfect re-establishment of health.

#### CONCLUSIONS

It seemed to us interesting to publish this report as an additional case of this condition and for the following reasons: (a) scarcity of clinical symptoms for establishing a diagnosis; (b) pathognomic value of the roentgen data; (c) perfect clinical-surgical cure.



## ABERRANT PANCREATIC TISSUE AS A ROENTGENOLOGIC PROBLEM\*

By GEORGE J. BAYLIN, M.D.

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**A**NATOMISTS and pathologists have long been conversant with variations in the placement of pancreatic tissue, but in scanning the roentgenological literature there is little specific reference to this problem. It is true that a number of writers make passing references to aberrant nodules of pancreas. Sahler and Hampton<sup>4</sup> describe the smooth defects occasionally produced in the stomach by aberrant pancreatic tissue and Strnad,<sup>5</sup> in his very comprehensive treatise on the duodenum, discusses the warty pancreatic growths frequently encountered in the duodenal mucosa.

Our attention was focused on this problem because of the experience gained recently in the study of a number of puzzling cases in which the roentgen diagnoses were accepted without reservation, proving incorrect in one instance and correct in another. Interestingly enough, the opinion that proved to be wrong was made with extreme assurance and pride, whereas the diagnosis that was correct was offered only after studied deliberation.

The close embryological relationship of the duodenum and pancreas, with the latter originating as buds from the former, makes it easy to understand why there are small clumps of pancreatic tissue frequently imbedded in the duodenum and other portions of the intestinal tract. It has long been recognized that duodenal diverticula may actually occur at sites where pancreatic arrests produce potential weak spots in the intestinal wall. When a diverticulum exists, no confusion ensues, for the pouch is ordinarily easily demonstrated.

What if the aberrant pancreatic nodule does not lead to an eventual outpouching, but, as in one case recently studied, pro-

duces a persistent filling defect in the duodenal mucosal pattern? Figure 1 shows such a defect in the descending loop of the duodenum. This was brought out well by the use of a pressure block and spot roentgenograms, but was suspected on the routine roentgenograms. Because the patient was jaundiced, and because his entire clinical course pointed to a diagnosis of cancer of the head of the pancreas, we very confidently interpreted the defect as evidence of a lesion of the ampulla of Vater. This diagnosis was readily accepted for it certainly was a satisfactory explanation of the patient's signs and symptoms. Moreover, intensive clinical studies were in no way at variance with the roentgenological interpretation.

After a period of adequate preoperative preparation, the patient was explored. When the peritoneal cavity was entered the surgeon noted immediately that the gallbladder was normal in size and that it emptied readily on slight manual pressure. Also, the head of the pancreas was normal. Palpation of the duodenum elicited a nodule on the posterior wall; therefore this structure was opened. The nodule was located just above the papilla and it was evident that it could in no way have been a causative factor in the production of the jaundice. A biopsy study revealed that the so-called roentgen ampullary defect was due actually to a cluster of aberrant pancreatic tissue.

The patient subsequently died and complete necropsy studies proved clearly that death was a result of an extensive inflammatory process of the liver. The changes in the liver were diffuse and had caused edema and necrosis of the biliary canaliculi, which of course accounted for the obstructive

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FIG. 1. Serial roentgenograms showing the defect in the duodenum that was incorrectly interpreted as cancer of the ampulla of Vater. A cluster of pancreatic tissue produced the constant change seen.

jaundice. It is interesting to note that in spite of the marked changes found in the liver, the various clinical tests pertaining to liver function failed to yield the information that would have aided materially in arriving at a correct diagnosis.

A number of instances have been recorded in which a defect of the ampulla of Vater was demonstrated roentgenographically and undoubtedly a cancer of this structure can and will at times produce certain roentgen pattern changes. Obviously, however, we are convinced that the problem of a correct diagnosis is not so simple as the mere finding of a filling defect in the vicinity of the ampulla. Feldman<sup>1</sup> has stated that by careful mucosal studies the normal ampulla can be identified, but certainly it is

not a roentgen appearance that can be consistently duplicated. Had we been able to localize the normal papilla, we naturally would not have been so positive in our interpretation of the defect demonstrated.

The more carefully the roentgenologist studies the gastrointestinal tract, the more frequently will such defects as described be encountered. When discovered in the absence of jaundice or symptoms they may present no particular problem. But, whenever they are detected in patients with jaundice or vague digestive symptoms it becomes extremely important for the roentgenologist to interpret the roentgenograms with a critical and cautious attitude.

Another aspect of aberrant pancreatic tissue which merits discussion is the pres-

ence of an encircling ring of pancreas about the duodenal loop. Lehman<sup>3</sup> reported what is perhaps the first case diagnosed prior to operation and in his article he reproduces photographs showing a smooth narrowing of the second portion of the duodenum. It was on the basis of this type of narrowing that Lehman was led to suspect the true underlying condition. Gross and Chisholm<sup>2</sup> in a recent article discuss the annular pancreas from the standpoint of diagnosis and treatment.

Recently we made the diagnosis of obstruction of the duodenum secondary to acute pancreatitis with possible annular constriction. Figures 2 and 3 show the duodenum prior to operation and some weeks after operation. The patient had been explored on several previous occasions prior to the present illness, and a few weeks before admission she began to complain of intermittent cramps, subsequently developing a constant epigastric pain associated with bouts of vomiting. Clinically, it was



FIG. 3. Roentgenogram after operation demonstrating the smooth narrowing of the duodenum when the inflammatory process had subsided.



FIG. 2. Obstruction of the second portion of the duodenum is clearly demonstrated. Note also the changes in the upper jejunum which are secondary to a pancreatitis.

felt that postoperative adhesions accounted for the symptoms. After proper clinical studies the patient was referred to the roentgenological department for consultation. The duodenal obstruction was demonstrated, which, coupled with the presence of an effusion at the left base and definite alterations in the small bowel pattern and physiology, led to a roentgen diagnosis of pancreatitis, plus probable circular constriction of the duodenum by aberrant or ectopic inflammatory pancreatic tissue. The operative findings coincided completely with the roentgen diagnosis.

The pancreas that encircles the duodenum completely or partially is not rare and the diagnosis must be considered seriously in every instance of a persistent narrowing in the size of the duodenal lumen at its second portion. Frequently, there may be no symptoms when the condition is present, but more often in the face of vague symptoms the true diagnosis is apt to be overlooked. Unless the roentgenologist acquaints himself with the possible variations

and aberrations in the duodenal pancreatic relationships he will undoubtedly be lured into error when he least expects it.

In this discussion of aberrant and ectopic pancreatic tissue and its roentgen manifestations, only a few of the manifold aspects have been touched upon. However, it is hoped that our experiences will serve in some measure to direct attention to this interesting aspect of abdominal roentgen studies, and that others will record their findings so that eventually a more complete understanding and appreciation of the subject may be attained.

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## NECROTIZING BRONCHOPNEUMONIA\*

### ITS RELATION TO RADIATION THERAPY OF CANCER OF THE ORAL CAVITY

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**N**ECROTIZING bronchopneumonia and necrotizing suppurative bronchopneumonia<sup>1</sup> are more descriptive and accurate terms for aspiration pneumonia. Necrosis of the bronchial walls and supuration of lung parenchyma supplied by the involved bronchus or bronchi are invariably present. The distribution is lobular and localized to one or more bronchopulmonary segments. Patients with cancer of the oral cavity have an excellent chance of developing this complication, particularly if the lesion interferes with deglutition. The presence of bacteria in the mouth, poor oral hygiene, advanced pyorrhea and root snags are also contributing factors. Pain on swallowing resulting in deficient nutrition, avitaminosis and lowered serum proteins all are conducive to the onset of pneumonia. If to these factors poorly planned radiotherapy is added, the chances of the patient aspirating broken-down tumor and bacteria becomes great.

Of the 14 cases we have observed, 3 had primary carcinoma of the tongue, 2 of the lip, 3 of the buccal mucosa, 5 of the larynx and 1 of the gum. Twelve of these patients died after completion of treatment, the shortest time interval before death being three days and the longest period eleven months. The 2 remaining patients, whose clinical symptoms and roentgen findings strongly suggest necrotizing bronchopneumonia, are well.

The clinical signs and symptoms of necrotizing bronchopneumonia are uniform and once seen are easily recognized. If a patient with cancer of the oral cavity begins to lose weight rather quickly and develops a rapid pulse with a low grade fever,

necrotizing pneumonia should be considered. There is often coughing, but little or no dyspnea or sputum. The breath is not foul as in lung abscess nor is clubbing of the nails present. Evidence of patchy consolidation is present on physical examination.

The diagnosis of necrotizing pneumonia by the roentgen ray may present difficulties. There are always changes present in the lower lobes and if the process is extensive enough it may also involve the upper lobes. The process being a bronchopneumonia, the changes will be lobular in character and of bronchial distribution. The areas of involvement will at first have a patchy to confluent cloudiness but as the disease progresses and liquefaction of the centers occurs, areas of rarefaction will make their appearance and the diagnosis will be more obvious. However, as the process continues, other areas may become involved so that the areas of rarefaction may be present in some zones and absent in others. Tuberculosis can be ruled out as the process is primarily basal and often extensive without apical involvement. Chronic passive congestion can be ruled out because of absence of engorgement of the vascular tree and enlargement of the heart. Atypical primary bronchopneumonia may be suggested but this disease usually appears in epidemic form and the clinical course is entirely different. Organization of the exudate with production of connective tissue surrounding the abscess produces zones of increased density. These areas may be circular, often with central rarefaction, and may suggest metastatic disease, although tumor originating from the lip, tongue, and larynx metastasize infrequently to the

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<sup>1</sup> Neuhof, H. Suppurative and necrosuppurative bronchopneumonia; their surgical aspects. *Dis. of Chest*, 1940, 6, 299-305.

lungs. Because of the patchy distribution and the fluffy appearance of the lesion, specific infections of fungus etiology may be considered. Examination of sputum should serve to rule out such infections as well as tuberculosis.

The pathology of necrotizing pneumonia is quite uniform, the changes varying only according to the duration and extent of the disease. The lungs are heavy and in our 12 autopsied cases had an average weight of 800 grams. The pleura over the involved lobes showed a fibrinous exudate, but in no instance had perforation and empyema occurred, a complication which would not have been unexpected. In every instance one or both lower lobes were involved: all lobes in 3 cases, four lobes in 3 cases, three lobes in 3 cases, two lobes in 2 cases and one lobe in 1 case. The bronchi were diffusely injected and in many instances contained thick, purulent material. In no instance was the disease of sufficiently long duration to produce bronchiectasis. The exudate was so heavy that the bronchi were often plugged. The pulmonary vessels were practically normal. Section of the lungs showed the involved lobes to be very heavy, the pneumonia patchy and bronchial in distribution. These pneumonic areas at times became confluent. Pressure of the involved lobes often produced pus from the small bronchi. Sometimes central softening of the involved areas had taken place and surrounding these areas of softening were firm yellowish zones which occasionally were well demarcated. Because of this sharp demarcation, an area of pneumonia located just beneath the pleura was thought on one occasion to be a metastatic focus. Various stages of the same process were often seen in different lobes, the earlier lesions having marked congestion and edema. The lungs had an offensive, but not a foul odor. Where the areas of necrosis had progressed at a rather rapid rate, small abscesses frequently formed which varied in size from a few millimeters up to 4 centimeters. Five cases had abscesses, but unfortunately it was impossible to determine definitely the dura-

tion of the pneumonia. Undoubtedly the evolution of the abscesses in many instances was very rapid because necrosis of bronchial walls is favored particularly by the anaerobes present.

The microscopic changes were also consistent. Foreign material, large clumps of bacteria, and polymorphonuclear leukocytes were often observed within the lumina of the bronchi. Partial or complete necrosis of the lining epithelium of the bronchi, which was usually present, resulted in some instances in the disappearance of the bronchial mucosa (Fig. 6). Where the process had progressed to abscess formation, lung parenchyma was completely absent. The wall of the abscess was lined with bacteria, fibrin and collections of polymorphonuclear leukocytes. Early organization commonly surrounded the abscess, this organization giving grossly a yellow color. In earlier lesions, marked congestion and edema were present.

The bacteriology was varied. Spirochetes, fusiform bacilli, anaerobic hemolytic streptococci, staphylococci, *Streptococcus viridans*, and various other organisms commonly seen within the oral cavity were usually found. Cultures always showed a mixed flora. Anaerobes were always present.

We believe that the primary cause of necrotizing pneumonia as associated with cancer of the oral cavity may be related to poorly planned radiotherapy. Scrupulous mouth hygiene and the extraction of all teeth is indicated before starting roentgen therapy. The size of the fields should be as small as possible, giving careful attention to the size of the lesion and to the filtration, with protraction of irradiation over a rather long period of time. If large fields are used in excessive doses with little or no filtration, extreme irradiation reaction with radionecrosis, edema, fibrosis and distortion of the swallowing structures may result.

After necrotizing pneumonia has developed, the chances of cure are very small unless early treatment is instituted. Since pneumococci are not the cause of necrotiz-

ing pneumonia, specific serum therapy is of no value. Sulfadiazine may affect some of the organisms but the anaerobes are not sensitive to it. Surgery was not indicated in any of the cases because extensive parenchymal disease was present with the abscesses. Roentgen therapy is probably the only specific agent which may be of value. A fairly large field should be selected and small doses given for three or four days. Two of the patients reported in this paper

Râles were present at the base of the right lung and in the axilla. Examination of the sputum revealed no tubercle bacilli but did show a mixed flora including anaerobes. The patient was running a low grade fever and had a high pulse rate (Fig. 1). Roentgenograms were taken on July 20 and 27, 1942 (Fig. 2, *A* and *B*), and the patient died on July 30, 1942.

This process was probably inflammatory but tuberculosis was considered. However, there was no involvement of the apices and sputum examination for acid-fast organisms was nega-

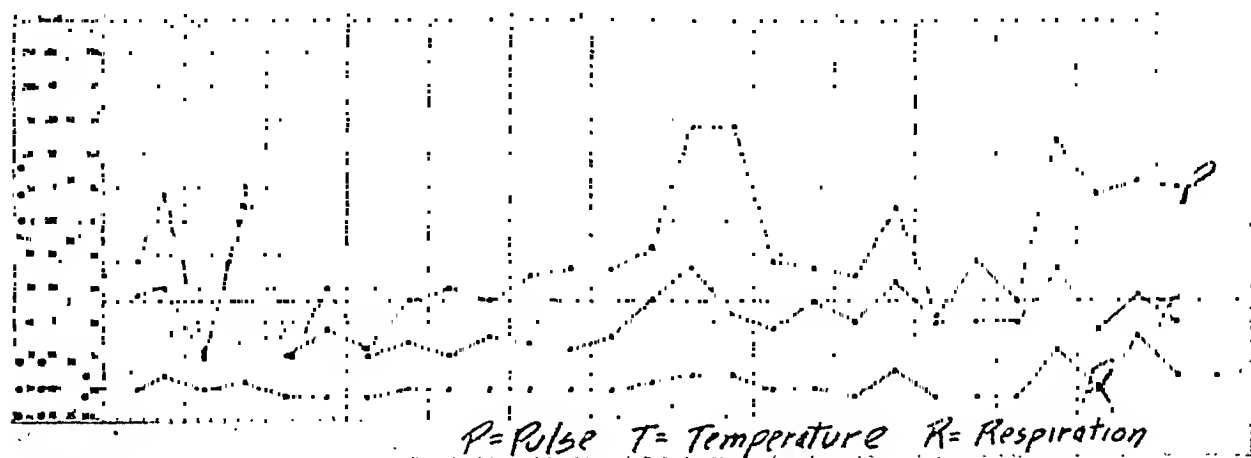


FIG. 1. Case 1. Note high pulse rate with relatively low temperature.

recovered from an apparently early necrotizing pneumonia, for which small doses of roentgen radiation were given.

The following cases illustrate the more significant findings in our studies of necrotizing pneumonia:

#### CASE REPORTS

**CASE 1 (EFSCH 4239).** R. D., male, aged fifty-six, was admitted to the hospital on July 17, 1942. In May, 1941, the tongue first became sore and the following October, at another hospital he was given 4,800 r to the submental region, and over two lateral 8 by 10 cm. fields. The lesion of the tongue was treated with 3,510 mg-hr. of radium introduced interstitially. This treatment was given over a fifteen day period, during which time the patient lost 40 pounds. In April, 1942, a hard mass appeared below the angle of the right mandible, evidently a metastatic node. Physical examination showed a chronically ill male with marked evidence of weight loss. The teeth were absent and the mucosa of the oral cavity was dry and smooth.

At autopsy the tongue was atrophic, the epiglottis was distorted and the lungs showed an advanced necrotizing pneumonia. The lungs together weighed 1,580 grams and pneumonia was present in all but the superior portions of both upper lobes. There were several small abscesses measuring no more than 2 cm. in the right lower and middle lobes. Surrounding these abscesses were yellowish zones suggesting early organization. No abscesses were present in the left lung.

The immediate cause of death was an advanced necrotizing bronchopneumonia with the formation of multiple abscesses. The patient died eleven months after the completion of roentgen therapy for carcinoma of the oral cavity. The poor nutrition and extensive radiation effect in the region of the base of the tongue and larynx, which caused marked fibrosis and distortion of the structures involved in deglutition, resulted in the aspiration of food particles and necrotic debris. There was no evidence of residual carcinoma in the tongue, but it was present in the cervical lymph nodes.





FIG. 2. Case 1. *A*, July 20, 1942. Note soft patchy to confluent cloudiness extending from the anterior end of the right second rib to the diaphragm together with small areas of increased translucency. There is also evidence of early disease in the dependent two-thirds of the left side of the chest. *B*, July 27, 1942. The lesions on the right have become more confluent and the areas of increased translucency more evident. Similar disease on the left is minimal.

CASE 11 (EFSCH 4165). C. J., female, aged thirty-nine, was admitted to the hospital on July 1, 1942. Two years before, a small lesion was noted directly beneath the tip of the tongue. This lesion increased in size rather rapidly and spread posteriorly to involve almost

the entire left side of the tongue. The patient had lost about 15 pounds in weight. Physical examination showed a chronically ill woman, with evidence of poor general nutrition. The teeth were in fairly good condition, but the entire lateral surface of the tongue was involved

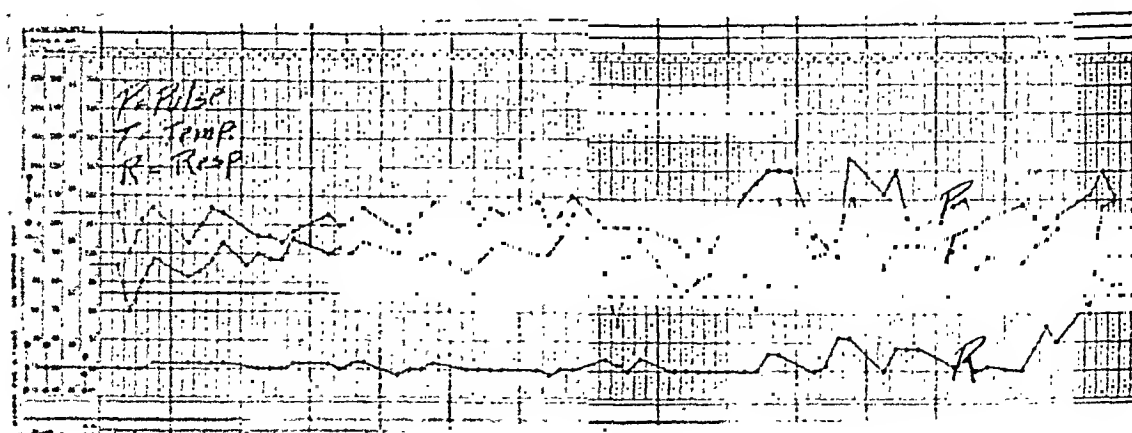


FIG. 3. Case 11. Note high pulse rate with relatively low temperature.

by hard firm tumor which extended posteriorly to the tonsil. There was a firm lymph node measuring 3 cm. in diameter in the left submaxillary area. The patient was given 7,500 r in thirty days, using 200 kv., 15 ma., 50 cm. target-skin distance, with a filtration of 0.5 mm. copper and 1 mm. of aluminum. These fields were lateral, submental, and measured 6 by 8 cm. During the entire stay in the hospital the patient ran a low grade fever with a relatively high pulse rate (Fig. 3). She lost about 20 pounds during therapy and weighed only 80 pounds when she died on July 13, 1942. A roentgenogram taken on June 2, 1942, was essentially negative. Another was taken on July 13, 1942 (Fig. 4), the day of her death.

At autopsy extensive necrotizing pneumonia was found to involve the entire left lung and the right lower lobe in which were multiple small abscesses. The bronchi contained large amounts of mucopurulent material. The larynx showed marked distortion of the epiglottis with edema and marked swelling of the glossopharyngeal

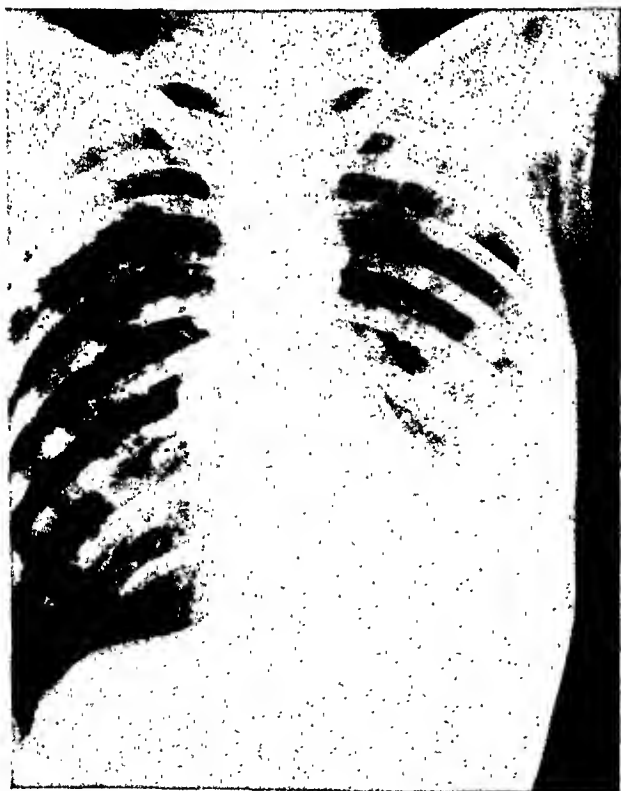


FIG. 4. Case II. There is minimal patchy cloudiness in association with the descending paravertebral trunk markings on the right. This change is most evident underlying the anterior end of the right fourth rib. The disease is considerably more marked on the left, increasing progressively downward resulting in complete opacity in the left base.



FIG. 5. Case II. Note distortion of the epiglottis with marked edema of the glossopharyngeal wall.

wall (Fig. 5). Microscopically, there was necrosis of the bronchial wall (Fig. 6) with multiple small areas showing central necrosis in large colonies of blue-staining bacteria. There was peripheral early organization of the exudate.

This patient received a large amount of roentgen therapy through large fields over a short period of time. This provoked a marked radio-epithelitis resulting in distortion of the epiglottis with fibrosis of the base of the tongue and marked edema of the glossopharyngeal wall. It is obvious that aspiration of foreign material and oral bacteria would be facilitated by these changes. Death occurred on the third day after completion of radiotherapy.

CASE III (EFSCH 4635). E. B., male, aged sixty-nine, entered the hospital October 12, 1942. The previous July, hoarseness first developed and was treated as chronic bronchitis. After a delay of several months, a diagnosis of carcinoma of the larynx was made. Physical examination revealed a fairly well developed male who presented bilateral enlarged cervical lymph nodes. In the region of the right piriform sinus

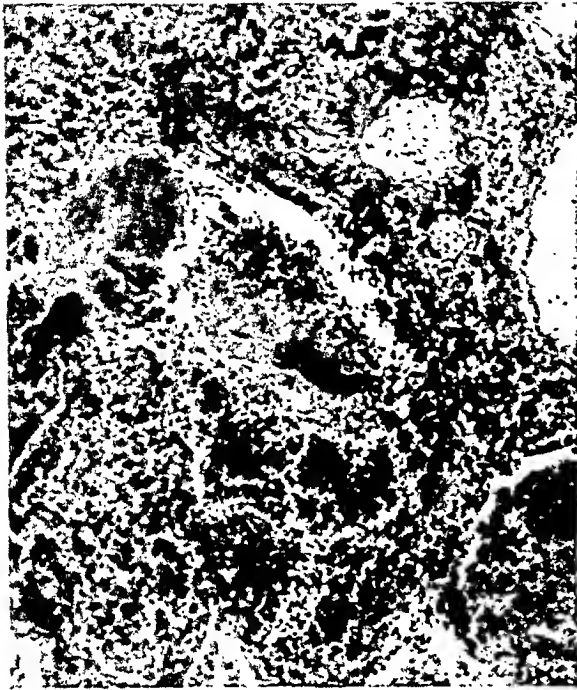


FIG. 6. Case 11. Photomicrograph (low power). Note necrosis of the wall of the bronchus (B). The bronchial lumen is filled with polymorphonuclear leukocytes and amorphous debris.

there was an elevated, reddish, crater-like lesion which was centrally necrotic and measured 1.5 cm. in diameter. Between October 19 and November 24, the patient received 6,500 r to two fields, one 10 by 15 cm. and one 8 by 10 cm., using 200 kv., 15 ma., 50 cm. target-skin distance, 1 mm. of copper and of aluminum. This treatment extended over a period of thirty-five days, during which time in spite of slight weight loss the condition remained good. By February 24, 1943, the left neck node, which previously measured 3 by 4 cm., had completely disappeared. There was, however, an additional node in the right cervical region measuring 2 cm. into which radium was implanted on March 10, and a total of 1,000 mg-hr. given. On June 9, there had been a weight loss of 17 pounds and the patient had been spitting up thick yellow sputum for several weeks. Laryngoscopic examination showed edema of the epiglottis which was fixed more or less in the open position. The vocal cords were spread apart and there was edema of the left cord with flattening of the right cord. A zone of ulceration measuring 2 by 1 cm. was observed in the region of the right piriform fossa. A roentgenogram of the chest

was taken on June 15, one day previous to his death (Fig. 8).

At autopsy there was a zone of necrosis in the piriform sinus extending to involve the right lateral wall of the pharynx (Fig. 9). The right arytenoid was almost entirely destroyed and the ala of the thyroid cartilage was exposed and necrotic. The endolarynx was not invaded by this necrosis. False and true cords were edematous and the epiglottis was distorted. Necrotizing pneumonia involved the entire left lung and the right lower lobe. The process in the right lower lobe was somewhat older than the left because organization of the exudate was present. Residual disease was found in the mesenteric, peripancreatic, cervical and aortic lymph nodes and in the liver.

The immediate cause of death was an extensive necrotizing bronchial pneumonia. The primary cause was necrosis in the region of the piriform sinus, which together with the changes in the larynx secondary to irradiation, paved the way for aspiration of necrotic debris. In giving roentgen treatment to lesions in this location, the margin of safety between adequate therapy and irradiation necrosis is dangerously limited. When irradiation necrosis occurs, necrotizing pneumonia almost inevitably follows.

CASE IV (EFSCH 5178). G. J. This patient, a man aged seventy, was admitted to the hospi-



FIG. 7. Case 11. Note multiple small abscesses.

tal on April 26, 1943. Three months previous to admission he noted increased hoarseness and he was referred to this hospital. Physical examination revealed a well developed, well nourished male. The mouth was edentulous. In the right piriform sinus there were areas of slough surrounded by an ulceration which involved the piriform and the epiglottic fold from the epiglottis down to and including the arytenoid. There were no enlarged cervical lymph nodes. Biopsy showed well differentiated epidermoid carcinoma, probably arising on the arytenoid epiglottic fold.

The right and left anterior cervical areas were given 3,800 and 2,675 r, respectively, through two fields which measured 6×8 cm. and the following factors were used: 200 kv., 15 ma., 50 cm. target-skin distance; filtration 1 mm. of copper and 2 mm. of aluminum. Radiation therapy was given twice a day for thirty-three days, starting with 100 r and gradually increasing to 150 r. A rather marked radio-epithelitis of the larynx developed and the patient lost 12 pounds in weight, but there were never any symptoms or signs of necrotizing pneumonia. On January 12, 1944, approximately eight months after completion of therapy, there was evidence of weight loss, dyspnea and increased



FIG. 8. Case III. Minimal patchy and considerable confluent cloudiness is present in both lung fields, extending from the hilar regions to the bases, more marked on the left.



FIG. 9. Case III. Note distortion of the epiglottis with necrosis and ulceration involving cartilage and pharyngeal wall.

fatigability. Examination revealed changes in the epiglottis with edema of the right arytenoid epiglottic fold and the anterior wall of the piriform sinus. A roentgenogram of the chest showed necrotizing pneumonia (Fig. 10A). He was given roentgen therapy using 218 kv., 1 mm. of copper and 1 mm. of aluminum; a 28 by 20 cm. field directed to the right side of the chest; 80 cm. target-skin distance, 100 r per treatment with a total dosage of 500 r. Symptomatically there was improvement with increase of weight. A roentgenogram taken on February 4, 1944 showed partial regression of the process. The last roentgenogram, May 10, 1944 (Fig. 10B), demonstrated complete clearing of the base, but linear bands of fibrosis were still observed in the second and third right interspaces. This suggests that healing of necrotizing pneumonia takes place at times by fibrosis, rather than resolution.

The second case which recovered from necrotizing pneumonia after roentgen therapy cleared by resolution. The treatment was given



FIG. 10. Case IV. *A*, January 13, 1944. Linear markings on the right are exaggerated but poorly defined. Coarse dense to patchy cloudiness is present throughout a large portion of the lung, especially marked in the first and second anterior interspace and superior to the diaphragm. Minimal disease is suggested underlying the anterior end of the left rib. *B*, May 10, 1944. Final roentgenogram reveals regression of the parenchymal changes with considerable fibrosis most evident in the right upper part of the chest.

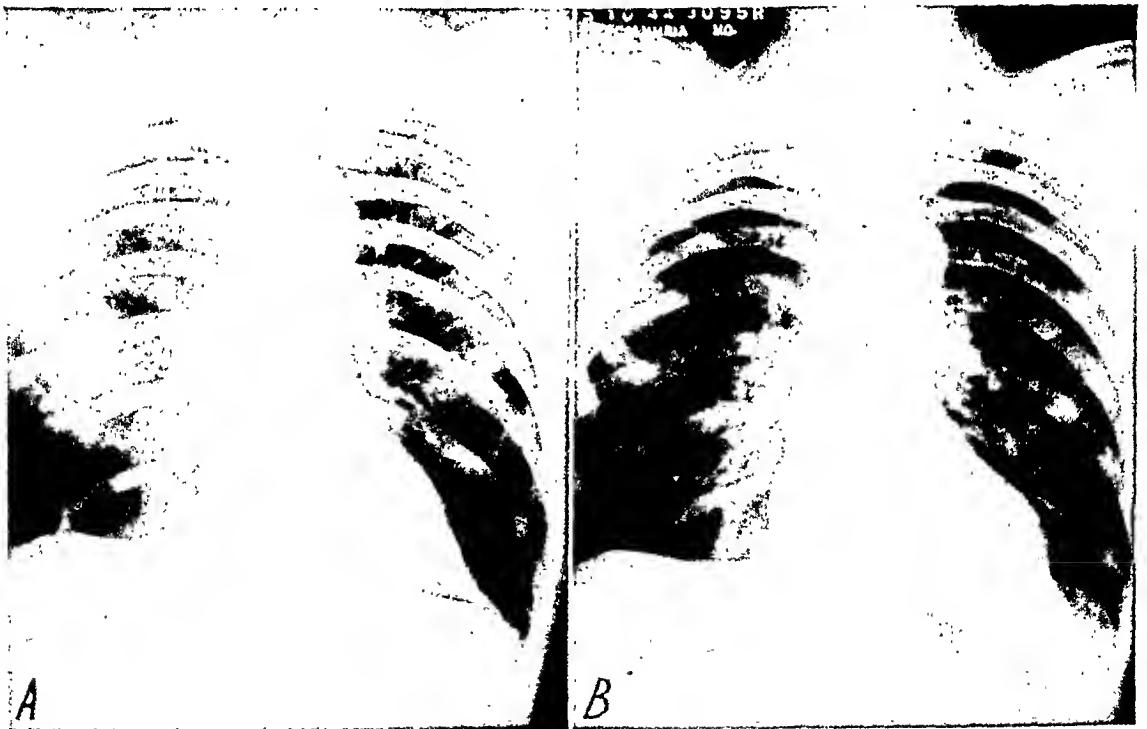


FIG. 11. *A*, September 7, 1943. Note area of irregular cloudiness in the right fourth and fifth anterior interspaces with a zone of indefinite translucency underlying the anterior end of the fifth rib. *B*, May 10, 1944. Final roentgenogram reveals complete resolution of the process.

in August, 1943. Resolution was nearly complete in January, 1944, and complete in May, 1944; a period of almost nine months (Fig. 11, *A* and *B*).

In both these cases, the diagnosis was made relatively early and a complete cure resulted from roentgen therapy. The diagnosis in both must be presumptive, but the clinical course and roentgen findings were typical of necrotizing bronchopneumonia.

#### DISCUSSION

Fourteen cases of necrotizing pneumonia, in 2 of which recovery took place, have been reported. This complication can occur during, immediately after, or relatively late after radiotherapy to cancer of the oral cavity and larynx. The clinical symptoms and signs are typical and a high pulse rate with a relatively low grade fever are of particular significance. The relation of the advanced pathology found by roentgen examination or at autopsy, in contrast to the rather meager clinical symptoms, often

comes as a surprise to the observer. The roentgenographic pattern on serial roentgenograms is characteristic and the differential diagnosis is not difficult, providing adequate knowledge of the historical and clinical aspects of the case is available. The differential diagnosis and the characteristic features of the roentgen findings have been discussed. The most important preventive measure is carefully planned roentgen therapy with particular attention to divided dose technique, selection of fields and adequate filtration. The distortion, fixation, fibrosis, edema and ulceration produced by large fields, little or no filtration and large dosage given over a short period of time, lead inevitably to this complication and to death. If the complication is diagnosed late in the course of necrotizing bronchopneumonia there is no treatment which will be of any value. Roentgen therapy according to the technique outlined may be curative, if the lesion is diagnosed at an early stage



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*Representatives on American Board of Radiology:* Douglas Quick, New York, N. Y., B. P. Widmann, Philadelphia, Pa., F. W. O'Brien, Boston, Mass.

*Twenty-eighth Annual Meeting:* to be announced.



# EDITORIAL

## THE QUESTION OF URETERAL OBSTRUCTION BY IRRADIATION

IN 1926, Herger<sup>1</sup> and Schreiner<sup>1</sup> were greatly impressed by the fact that in 32 autopsies of patients dying from cancer of the cervix, 66 per cent showed gross pathologic changes of the urinary apparatus. As a result of this observation, a systematic study by means of cystoscopy and retrograde pyelography was undertaken on a series of 50 cases of carcinoma of the cervix of clinical Stage III and IV before any treatment was instituted. In 50 per cent a unilateral and sometimes a bilateral obstruction of the lower ureters was found associated with secondary hydronephrosis and pyonephrosis. The authors concluded that metastases and carcinomatous infiltration of the broad ligaments or bladder wall undoubtedly accounted for the obstructive process. In one case arriving at autopsy later, it was noted that radiation therapy administered subsequently resulted in complete eradication of the carcinoma, yet the patient died from complications of the upper urinary tract which apparently could not be influenced.

Since then, stress has been laid repeatedly on the important rôle which the frequent involvement of the upper urinary apparatus has in the outcome of all malignant neoplasms located within the pelvis. In the beginning, the expanding tumor exercises a slight pressure on the base of the bladder displacing the lower ureteral orifices or encroaches directly upon the lumen of the ureter itself. In either case, the resulting narrowing leads to a slowing down of the flow of the urine. During this period the patients have no symptoms and therefore

an involvement of the urinary tract is discovered only accidentally or through systematic checkup examinations. Later, as the disease advances, the surrounding structures become invaded either by diffuse infiltration of malignant cells or by a superimposed cellulitis, and a progressive obstruction with hydroureter and hydronephrosis, sometimes associated with pyoureter and pyonephrosis, develops. It is almost universally true that 65 to 70 per cent of the patients afflicted with carcinoma of the cervix do not seek medical aid until the disease has reached clinical Stage III or IV, and therefore it is understandable that urinary complications should be encountered most frequently in connection with this type of lesion. But they also occur quite commonly in tumors of the bladder and prostate, in ovarian tumors and in other pelvic neoplasms. Seaman and Binnig<sup>2</sup> found that not even the caudalward located carcinomas of the rectum can escape them. These authors have performed routine investigations by means of intravenous pyelography and cystoscopy in a series of 68 cases of carcinoma of the rectum. They noted that in 13.2 per cent a simple or infected unilateral hydronephrosis was present at the time of the initial examination and that in another 13.2 per cent a similar condition developed at shorter or longer intervals after the operation. No radiation therapy was given in any of these cases.

During the last few years an increasing number of articles has appeared in the literature attributing the ureteral obstruction with the consequent hydronephrosis to

<sup>1</sup> Herger, C. C., and Schreiner, B. F. Strictured ureters, hydronephrosis and pyonephrosis occurring in cancer of cervix uteri; based on study of 82 cases. *Surg., Gynec. & Obst.*, 1926, 43, 740-743.

<sup>2</sup> Seaman, J. A., and Binnig, C. Urological complications of cancer of rectum. *J. Urol.*, 1941, 46, 777-797.

the effect of the irradiation. This applies especially to carcinoma of the cervix where radiation therapy is most frequently used. Very recently, Mansur<sup>3</sup> arrived at the conclusion that ureteral obstruction must be assumed as a "definite hazard" and that it represents "a frequent aftermath of heavy irradiation of the cervix."

The series of these articles was apparently started by Bugbee<sup>4</sup> when, in 1934, he published a group of 8 cases which he nephrectomized following irradiation of the cervix for carcinoma. Some of these cases were treated by radium alone, others by a combination of deep roentgen therapy and radium. The dosage was admittedly smaller than that in current use and no bladder injury of any kind was noted. In a few cases radium needles were implanted around the cervix and into the proximal parametria. Four of the cases died within a short time after the operation and autopsy revealed the presence of carcinoma metastases in all. Two of them showed extension or metastasis of the carcinoma in the occluded ureter. Four patients were still alive at the time of the publication of the paper, one with definite recurrence and ascites. It is the author's opinion that the early breaking down of the tumor tissue after irradiation, with the rapid cicatrization which resulted, caused the early ureteral obstruction and also accounted for the uretero-vaginal fistulae which occurred in 3 of the cases.

In subsequent publications, most of the evidence in support of the theory that ureteral obstruction is caused by irradiation was derived from autopsy findings. Although the observations were usually limited to individual cases, the fibrosis encountered around the ureters and elsewhere within the pelvis has induced not a few of the investigators to assume that in the absence of any residue of the malignant neoplasm such a process is solely the sequela

of irradiation. In particular, Mansur<sup>3</sup> became convinced that the obstruction is the result of compression by scar tissue rather than actual contracture of the ureter itself. He studied clinically and examined post-mortem a case irradiated for carcinoma of the cervix in which, despite a mild reaction, a firm scar tissue mass was found nine months later to have obstructed both ureters. When the fibrous band about the ureters was cut, a fairly good opening of the lumen was found on each side, although some fibrous contracture had taken place within the walls. Wigby<sup>5</sup> likewise observed clinically and at autopsy a case of cancer of the cervix which following combined roentgen and radium irradiation developed bilateral hydronephrosis and died eleven months later. The marked thickening of the structures around the lower ureters without any trace of the former cancer suggested fibrosis incidental to radiation treatment, but in this case at the same time there was evidence of marked third degree reaction of the lower bowel, and the whole pelvis was a hard mass containing rectum, vagina, uterus, bladder and surrounding tissues.

Because of the frequency with which complications of the urinary apparatus are apt to occur, especially in connection with carcinoma of the cervix, several authors concentrated their attention on routine preliminary urologic studies to determine if some of the ureteral obstruction ordinarily attributed to the effect of irradiation might not have been present before the institution of any treatment at all. Graves and Kickham<sup>6</sup> investigated urologically and by post-mortem examination a series of 174 cases of cancer of the cervix, belonging to clinical Stage III and IV, and they found positive signs of ureteral obstruction in 123 cases, or 70.7 per cent. Of these, 46 were in Stage III and 77 in Stage IV, indicating that the farther the cancer had progressed, the more

<sup>3</sup> Mansur, E. E. Ureter and its involvement in pelvic irradiation. *Radiology*, 1944, 25, 147-154.

<sup>4</sup> Bugbee, H. G. Ureteral occlusion following radium implantation into the cervix. *J. Urol.*, 1934, 32, 439-448.

<sup>5</sup> Wigby, P. E. Post-irradiation stricture of rectum and sigmoid following treatment for cervical cancer. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1943, 49, 307-320.

<sup>6</sup> Graves, R. C., and Kickham, C. J. E. Urological complications of carcinoma of the cervix. *Am. J. Surg.*, 1937, 53, 163-172.

frequent became the urinary complications. The obstruction, as a rule, was encountered at a point 4 to 6 cm. above the bladder where the ureter lies beneath the broad ligament and adjacent to the cervix. Valk<sup>7</sup> in 1942, undertook a systematic study by means of retrograde and intravenous urography in 50 women afflicted with cancer of the cervix, 44 of whom were in clinical Stage IV. He, too, found that in 64 per cent of these women a definite upper urinary tract disease, varying from unilateral hydronephrosis to bilateral non-visualization was already present at the first urological examination, before any radiation therapy was started. By continuing the systematic examinations periodically after the completion of the irradiation series, he further found that instrumental dilation of the involved ureters could in no case produce regression of the hydronephrosis when once established, even if the cancer was eradicated, although temporary symptomatic amelioration was often obtained. It may appear of some significance in connection with these observations that Cosbie<sup>8</sup> who, in the same year, published the autopsy findings from an entirely different source found that of 24 cases of cancer of the cervix who died despite the radiation therapy given, in 17, or 70.8 per cent, there was ureteral obstruction associated with hydronephrosis or pyonephrosis. In every case the obstruction was the result of malignant infiltration of the cellular tissue.

Jaffe, Meigs, Graves and Kickham<sup>9</sup> extended their systematic urologic investigations to cases of all clinical stages and followed them through in those who survived for a period of five years or longer. These authors have chosen a group of 70 patients with cancer of the cervix treated by irradiation at the Pondville Hospital and have examined them by means of cystoscopy,

catheterization of the ureters, whenever possible, and by retrograde and intravenous urography. The examinations were made prior to the institution of the treatment and at more or less regular intervals thereafter. Five of the patients belonged in Stage I, 3 in Stage II, 43 in Stage III and 19 in Stage IV. At the initial examination, there was positive evidence of ureteral obstruction in 25 cases, or 35.7 per cent of the entire group. None of the cases in Stages I and II showed an involvement of the ureters in the beginning and they remained negative throughout the followup period. According to the authors, this is a very important observation since it indicates that ureteral obstruction is not due to radiation effect on the ureteral wall. In 2 cases of Stage III there was a normal appearing urinary tract prior to the treatment, but unilateral obstruction developed in one twenty-one months after irradiation and bilateral obstruction in the other seven months after irradiation. Following instrumental dilation both cases promptly recovered and they are well five years and eight months, and six years after treatment respectively. This fact seems to indicate that the ureteral obstruction in the two cases was the result of replacement fibrosis of the carcinomatous infiltration of the broad ligament, as a result of the radiation therapy given. In those instances of Stages III and IV, in which the involvement of the ureters was present at the beginning, apart from temporary symptomatic improvement, no regression of the hydronephrosis could be obtained by the urologic treatment. The patients died of uremia even if irradiation had led to a complete eradication of the carcinoma.

There are only a few animal experiments available to substantiate the clinical observations. In 1926, Martin and Rogers<sup>10</sup> demonstrated that a dose of 75 milligram-hours yielded by two 6.25 mg. monel steel radium needles placed on either side of a dog's ureter produced complete occlusion

<sup>7</sup> Valk, W. L. Urological complications of carcinoma of the cervix. *J. Urol.*, 1942, 47, 686-688.

<sup>8</sup> Cosbie, W. G. Complications of irradiation treatment of carcinoma of the cervix. *Am. J. Obst. & Gynec.*, 1941, 42, 1003-1008.

<sup>9</sup> Jaffe, H. L., Meigs, J. V., Graves, R. C., and Kickham, C. J. E. Ureteral and renal complications of carcinoma of the cervix; their classification and management. *Surg., Gynec. & Obst.*, 1940, 70, 178-184.

<sup>10</sup> Martin, C. L., and Rogers, F. T. Effect of irradiation on the ureter. *Am. J. Roentgenol. & Rad. Therapy*, 1926, 16, 215-218.

and hydronephrosis. But a subsequent experiment with a heavily filtered radium capsule showed that 2.5 threshold erythema doses applied directly to the ureter produced no damage. Recently Hueper and his coworkers<sup>11</sup> performed a series of experiments on dogs to study the radiation effect on the bladder. Although they were able to produce severe radiocystitis, no damage was reported to the ureters. Obviously, additional careful investigations are necessary before the question is definitely settled.

A correlation of the above enumerated data permits several conclusions. (1) Ureteral obstruction occurs so frequently in all malignant neoplasms located within the pelvis that it must be considered as a natural sequence during the later stages of the disease. There can be no doubt that many instances attributed in the literature to the effect of the irradiation belong in this category, especially if no systematic urologic studies anteceded the treatment. (2) Once a hydronephrosis or pyonephrosis is established, the gradual destruction of the kidney leading up to terminal uremia can be delayed but not prevented with the means at our disposal today. Even complete eradication of the carcinoma by irradiation cannot stop this inevitable outcome. Therefore, the demonstration at autopsy of obstruction of the ureters by scar tissue in the absence of any residue of the malignant tumor does not constitute proof that the irradiation is the responsible factor. If prior to the treatment the urologic findings were entirely negative, one may assume that the fibrosis is part of the healing process. (3) Gross overdosage or faulty technique may undoubtedly lead to fibrotic obstruction of the ureters but if such is the case a marked fibrosis with severe mucosal reactions must be encountered throughout the entire irradiated volume of the pelvis. Exception is made to the interstitial radium puncture

where it is conceivable that some needles are inserted so close to the ureters that damage results locally. However, with the dosage and technique as used at present in routine radiation practice no injury is done to the ureters themselves. The fact that the obstruction is always noted in the anatomic proximity of the broad ligament, that is 4 to 6 cm. above the lower ureteral orifice, suggests that the effect must occur secondarily from processes in this region. The non-involvement of the urethra which during the same course of irradiation is often subjected to even larger doses than the ureters and the wholly unknown obstruction of the upper ureters when irradiation of the abdomen is undertaken for some other reason would also tend to support such a view. (4) It is assumed by several authors that the periureteral fibrosis in those instances in which the initial urologic examination was negative and ureteral obstruction developed months or years after treatment is the result of replacement of the carcinomatous permeation of the broad ligaments by scar tissue incidental to irradiation. There is, however, also the factor of a secondary infection of the carcinoma to be considered. It is common knowledge that all infections of the abdomen and pelvis heal with marked adhesions and there is no reason why this should not be true also in the case of a healing infected cancer. The importance of secondary infection in carcinoma of the cervix was studied in detail by Cosbie.<sup>8</sup> By taking routine cultures from the cervix of 243 patients, he found that of 47 patients with positive hemolytic streptococcus cultures, 25 developed some complications subsequently, consisting of pyometria, cellulitis, thrombophlebitis, pelvic abscess, peritonitis and septicemia. In another series of 176 patients, routine anaerobic cultures were taken. Of these, 72 showed positive infection and 32 developed inflammatory complications later. The cultures of 129 patients were negative and even in this group 28 developed some sort of an infection later. It is probable that in

<sup>11</sup> Hueper, W. C., Fisher, C. Virginia, de Carvajal-Forero, J., and Thompson, M. R. Pathology of experimental roentgen-cystitis in dogs. *J. Urol.*, 1942, 47, 156-167.

not a few of the cases reported in the literature, the fibrosis observed around the ureters and elsewhere in the pelvis is the result of the natural healing of the infection following eradication of the carcinoma by the irradiation. Such viewing of the problem has also a practical significance. It may stimulate in the future experimentation with the newer sulfa drugs or penicillin, which, if administered in conjunction with irradiation, may lead, through rapid clearing up of the infection, to reduction or pre-

vention of the fibrosis and thus of the ureteral obstruction.

Taken as a whole, there is insufficient proof to warrant affirmation that obstruction of the ureters is the direct or indirect result of irradiation as used in current practice for the treatment of malignant neoplasms situated within the pelvis. In fact, as newer evidence accumulates, the conviction grows that the opposite is true.

T. LEUCUTIA



# SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

*Items for this section solicited promptly after the events to which they refer.*

## MEETINGS OF ROENTGEN SOCIETIES\*

### UNITED STATES OF AMERICA

#### AMERICAN ROENTGEN RAY SOCIETY

*Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: 1945, canceled.*

#### AMERICAN COLLEGE OF RADIOLOGY

*Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago. SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION*  
*Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio.*

#### ARKANSAS RADIOLOGICAL SOCIETY

*Secretary, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.*

#### RADIOLOGICAL SOCIETY OF NORTH AMERICA

*Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: 1945, to be announced.*

#### RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

*Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.*

#### SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

*Secretary, Dr. Earl R. Miller, University of California Hospital, San Francisco, Calif.*

#### RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

*Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.*

#### SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY

*Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.*

#### RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL ASSOCIATION

*Secretary, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.*

#### RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

*Secretary, Dr. Roy G. Giles, Temple, Texas.*

#### BROOKLYN ROENTGEN RAY SOCIETY

*Secretary, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N. Y. Meets monthly on fourth Tuesday, October to April.*

#### BUFFALO RADIOLOGICAL SOCIETY

*Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.*

#### CHICAGO ROENTGEN SOCIETY

*Secretary, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.*

#### CINCINNATI RADIOLOGICAL SOCIETY

*Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.*

#### CLEVELAND RADIOLOGICAL SOCIETY

*Secretary, Dr. D. D. Brannan, 11311 Shaker Blvd., Cleveland 4, Ohio. Meets at 6:30 P.M. at Allerton Hotel on fourth Monday each month, October to April, inclusive.*

#### DALLAS-FORT WORTH ROENTGEN STUDY CLUB

*Secretary, Dr. N. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meetings held in Dallas on odd months and in Fort Worth on even months, on third Monday, at 7:30 P.M.*

#### DENVER RADIOLOGICAL CLUB

*Secretary, Dr. Edward J. Meister, 366 Metropolitan Bldg., Denver, Colo. Meets third Friday of each month at Denver Athletic Club.*

#### DETROIT ROENTGEN RAY AND RADIUM SOCIETY

*Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.*

#### FLORIDA RADIOLOGICAL SOCIETY

*Acting Secretary, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Fla. Meetings in May and November.*

#### GEORGIA RADIOLOGICAL SOCIETY

*Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.*

#### RADIOLOGICAL SOCIETY OF KANSAS CITY

*Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month at a place designated by the president.*

#### ILLINOIS RADIOLOGICAL SOCIETY

*Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.*

#### INDIANA ROENTGEN SOCIETY

*Secretary, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meets annually second Sunday in May.*

#### IOWA X-RAY CLUB

*Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.*

#### KENTUCKY RADIOLOGICAL SOCIETY

*Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.*

#### LONG ISLAND RADIOLOGICAL SOCIETY

*Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.*

#### LOUISIANA RADIOLOGICAL SOCIETY

*Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.*

#### MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

*Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.*

#### MILWAUKEE ROENTGEN RAY SOCIETY

*Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.*

#### MINNESOTA RADIOLOGICAL SOCIETY

*Secretary, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.*

#### NEBRASKA RADIOLOGICAL SOCIETY

*Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.*

#### NEW ENGLAND ROENTGEN RAY SOCIETY

*Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.*

#### RADIOLOGICAL SOCIETY OF NEW JERSEY

*Secretary, Dr. H. R. Brindle, 501 Grand Ave., Asbury Pk. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.*

#### NEW YORK ROENTGEN SOCIETY

*Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.*

#### NORTH CAROLINA ROENTGEN RAY SOCIETY

*Secretary, Dr. Major Fleming, Rocky Mount, N. C. An*

\* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

- nual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.
- NORTH DAKOTA RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.
- CENTRAL NEW YORK ROENTGEN RAY SOCIETY**  
*Secretary*, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.
- OHIO RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.
- PACIFIC ROENTGEN SOCIETY**  
*Secretary*, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.
- PENNSYLVANIA RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. L. E. Wurster, 416 Pine St., Williamsport. Next annual meeting, Hotel William Penn, Pittsburgh, May 5-6, 1945.
- PHILADELPHIA ROENTGEN RAY SOCIETY**  
*Secretary*, Dr. R. P. Barden, University Hospital, Meetings first Thursday of each month from October to May inclusive at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.
- PITTSBURGH ROENTGEN SOCIETY**  
*Secretary*, Dr. L. M. J. Freedman, 4800 Friendship Ave. Meets second Wednesday each month, 4:30 P.M., October to June, Pittsburgh Academy of Medicine.
- ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.**  
*Secretary*, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.
- ROCKY MOUNTAIN RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. A. M. Popma, 220 N. First St., Boise, Idaho.
- ST. LOUIS SOCIETY OF RADIOLOGISTS**  
*Secretary*, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.
- SAN DIEGO ROENTGEN SOCIETY**  
*Secretary*, Dr. Henry L. Jaffe, Naval Hospital, Balboa Park, San Diego, Calif. Meets monthly on first Wednesday at dinner.
- SAN FRANCISCO RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. Carlton L. Ould, University of California Hospital, San Francisco 22. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.
- SHREVEPORT RADIOLOGICAL CLUB**  
*Secretary*, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.
- SOUTH CAROLINA X-RAY SOCIETY**  
*Secretary*, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.
- TENNESSEE RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.
- TEXAS RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. Asa E. Seeds, Baylor Hospital, Dallas, Texas. Next annual meeting, Temple, Texas, Jan. 17, 1945.
- UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING**  
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.
- UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE**  
*Secretary*, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00-5:00 P.M., Room 301, Service Memorial Institute.
- VIRGINIA RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.
- WASHINGTON STATE RADIOLOGICAL SOCIETY**  
Meets fourth Monday each month, October through May, College Club, Seattle.
- X-RAY STUDY CLUB OF SAN FRANCISCO**  
*Secretary*, Dr. J. M. Robinson, University of California Hospital. Meets monthly, third Thursday evening.
- CUBA**
- SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA**  
*President*, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.
- BRITISH EMPIRE**
- BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY**  
Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W. 1.
- SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)**  
Meets on the third Friday of each month at 4:45 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.
- FACULTY OF RADIOLOGISTS**  
*Secretary*, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.
- SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS**  
*Secretary*, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.
- RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION**  
*Secretary*, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.
- CANADIAN ASSOCIATION OF RADIOLOGISTS**  
*Secretary*, Dr. J. W. McKay, 1620 Cedar Ave., Montreal, P. Q.
- SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION**  
*Secretary*, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.
- RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION**  
*Secretary*, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.
- SOUTH AMERICA**
- SOCIEDAD ARGENTINA DE RADIOLOGIA**  
*Secretary*, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.
- CONTINENTAL EUROPE**
- SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA**  
*Secretary*, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.
- SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)**  
*Secretary* for French language, Dr. A. Grosjean La Chaux de Fonds.  
*Secretary* for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.
- SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE**  
*Secretary*, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.
- ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.**  
*Secretaries*, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.
- LENINGRAD ROENTGEN RAY SOCIETY**  
*Secretaries*, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.
- MOSCOW ROENTGEN RAY SOCIETY**  
*Secretaries*, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.
- SCANDINAVIAN ROENTGEN SOCIETIES**  
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different



## MINNESOTA RADIOLOGICAL SOCIETY

The Annual Meeting of the Minnesota Radiological Society was held at Rochester, Minnesota, on April 13, 1944. At this meeting, Dr. Ralph S. Bromer of Bryn Mawr, Pennsylvania, delivered the Carman Lecture and was the guest speaker at the annual dinner. The following officers were elected for 1944-1945: *President*, K. Wilhelm Stenstrom, Ph.D., Minneapolis; *Vice-President*, Dr. Russell W. Morse, Minneapolis; *Secretary-Treasurer*, Dr. Annette T. Stenstrom, Minneapolis.

The Fall Meeting was held in Minneapolis on December 9, 1944, at the Nicollet Hotel. At the scientific session in the afternoon the following papers were read: "Radiation Therapy of Mastitis," by Solveig Berg, M.D. "X-ray Treatment of Malignant Tumors of the Testis and Results of Treatment," by G. M. Kelvey, M.D. "Bone Metabolism," by Edward Flink, M.D. The dinner at the Nicollet Hotel in the evening was given in honor of Dr. Leo G. Rigler, Professor of Radiology at the University of Minnesota. At this time, the Leo G. Rigler Fund of \$11,000 was presented to the University of Minnesota to establish the Leo G. Rigler Lectureship in Radiology. This fund was raised by former pupils and colleagues and friends of Dr. Rigler. Dr. Fred J. Hodges of the University of Michigan was the first lecturer of this series. His subject was "The Teaching of Radiology."

ANNETTE T. STENSTROM  
Secretary-Treasurer

## LEO G. RIGLER—AN APPRECIATION

Over one hundred friends of Dr. Leo G. Rigler gathered at a special dinner in Minneapolis, December 9, 1944, to wish him well. The occasion was the Fall Meeting of the Minnesota Radiological Society, and the guest speaker was Dr. Fred J. Hodges, Professor of Roentgenology, University of Michigan, whose subject was "The Teaching of Radiology." Dr. Walter

J. Ude, representing the Minnesota Radiological Society and friends of the honored guest, presented over \$10,000 to the University of Minnesota to establish the Leo G. Rigler Lectureship in Radiology. This was accepted by Dean H. S. Diehl. Speakers were Dr. Robert G. Allison, Dr. George E. Fahr, Dr. E. T. Bell, and others. For some time the radiologists have wanted to express to Dr. Rigler their appreciation for his untiring efforts in their behalf. When his friends in other branches of medicine heard of this proposal, they too wanted to help. The sum accumulated so rapidly that it quickly reached the desired amount.

Leo George Rigler was born October 6, 1896, in Minneapolis. He attended the University of Minnesota, from which he received his M.D. degree in 1920. Following an internship in St. Louis City Hospital, St. Louis, Missouri, and practice in North Dakota, he was named Teaching Fellow in Internal Medicine, University of Minnesota (1921-1922). The following year he was appointed Roentgenologist at Minneapolis General Hospital, largely as the result of his interest in the roentgen diagnostic aspects of medicine. He was named Associate Professor of Radiology in 1927, and Professor in 1929. In 1935 he became Chief of the Department and has served in that capacity up to the present. In 1930 the State Board of Institutions made him a consultant. In 1941 the Minneapolis General Hospital named him Chief of the Department of Roentgenology. Prior to accepting the departmental appointment, Dr. Rigler completed his studies in Europe, spending most of his time with Professor Gösta Forsell in Stockholm, Sweden. There he also learned to speak Swedish.

Dr. Rigler is a member of Alpha Omega Alpha, Sigma Xi, American Medical Association, Hennepin County Medical Society, Minnesota State Medical Association, Minneapolis Academy of Medicine, Minnesota Academy of Medicine, American Roentgen Ray Society, Radiological Society of North America, Minnesota Radiological Society, American College of Radi-

ology (fellow), American Association of Thoracic Surgery and the American Association for the Advancement of Science. He is married (Matil Sprung, 1920), and has three children, Stanley, Nancy and Ruth. Dr. Rigler is the author of "Outline of Roentgen Diagnosis" (Lippincott), Second Edition, 1943, and many scientific papers.

As long as any of us can remember, Leo Rigler has been doing things for other people. The list is long and impressive. He has arranged and organized departmental conferences with most of the other departments in the hospital, as well as with the pre-clinical branches. He is always ready and willing to speak at medical gatherings and to teach special courses at the Center for Continuation Study. His contributions to graduate training include service not only to members of his own department but to practically every other clinical department. He has been instrumental in putting life and vigor into the Minnesota Radiological Society and he has been active in the councils of national associations. In recent years he has made a large contribution to War-Time Graduate Medical Meetings through his visits to all the hospitals in our area. It is at clinical pathological conferences that he is at his best, standing in front of the group, calling attention to what he sees and giving his conclusions just ahead of the pathologist with his postmortem report. He has been associated with roentgenology during its greatest period of development, and he has made a significant contribution to this specialty.

It is just and fitting that this honor should come to Dr. Rigler. The University of Minnesota has been a better place because of his contributions and all of us look forward to profitable years of association with him.

WILLIAM A. O'BRIEN

Director of Post Graduate Medical  
Education  
University of Minnesota

## DR. W. D. COOLIDGE RETIRES, BUT CONTINUES AS X-RAY CONSULTANT

Under the above title appears a news item of interest to all radiologists. It is from the *Victor News* of January, 1945, and is quoted in part as follows:

President Charles E. Wilson recently announced the retirement of Dr. William D. Coolidge as vice-president and director of the General Electric research laboratory, a position he has held since 1940.

Dr. C. G. Suits, assistant to the director, has been elected a vice-president and in that capacity will be in charge of the company's research laboratory.

The announcement of his retirement does not mean that Dr. Coolidge is divorcing himself entirely from his chosen field of work—the science of x-ray. Instead, he will devote himself to activities as research and engineering consultant to the General Electric X-Ray Corporation in Chicago.

Entering the General Electric Research Laboratory in 1905, Dr. Coolidge became assistant director in 1908, associate director in 1928, director in 1932, and vice-president and director of research in 1940. Outstanding through the years was his resourcefulness in experiment.

That Dr. Coolidge's discoveries and inventions have wrought a profound change in our way of life is inescapable. He has obtained 83 patents himself, and indirectly his guiding influence has accounted for many other scientific triumphs to help mankind.

Dr. Coolidge is probably best known for his development of the Coolidge hot cathode x-ray tube, which followed his fundamental research in, and development of, ductile tungsten.

Many were the problems he had to solve before he finally attained his goal. But triumph he did, and the Coolidge x-ray tube soon substantially superseded all previous types. And the use of x-rays became a science instead of an art.

Honors have been bestowed upon him through the years, including an honorary M.D. degree from the University of Zurich which he received in 1937.

## BOOK REVIEWS

*Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.*

**THE HISTORY OF MINERS' DISEASES: A MEDICAL AND SOCIAL INTERPRETATION.** By George Rosen, M.D. With an Introduction by Henry E. Sigerist, M.D. Cloth. Price, \$8.50. Pp. 490, with illustrations. New York: Schuman's, 1943.

This book of almost five hundred pages at once aroused the reviewer's curiosity as to why such a voluminous publication should be devoted to a field apparently as narrow as the history of miners' diseases. Unfortunately, the historical development of any disease is too often considered to be of little importance by many physicians. This is probably why, in systems and textbooks of medicine, such material is placed in small type, and allotted only one or two brief paragraphs at the most. In some instances, moreover, the reviewer is suspicious that even these references are composed of a few random notes unenthusiastically copied from some handy source without proof of their authenticity. When thus garnered and recorded without careful evaluation, they are likely to contribute little except perhaps, in some instances, the perpetuation of historical errors.

The publication, therefore, of such a text by Dr. Rosen with the approval and commendation of an authority with the standing of Henry E. Sigerist of the Johns Hopkins Institute of the History of Medicine, merits the attention of the profession at large. This is not only on account of the information made available and the enjoyable reading which the volume provides, but also because it stimulates one to contemplate carefully the motive underlying the preparation and publication of such an exhaustive treatise in this field. This is adequately recorded in the preface by the author. In brief, it is to trace the growth of knowledge concerning the diseases which affect miners and to correlate this information with the advances in the basic medical sciences as well as with the varying social and economic conditions which have contributed to the rise of occupational disease among miners. I have no idea if the author had the following thought in mind but he could have said, very properly: the purpose of the book is to emphasize that one does not really have a sound and comprehensive grasp

of any subject unless he goes back to the beginning and acquires a thorough knowledge and understanding of its development, step by step. Furthermore, not only must one have accumulated information dealing with the disease itself, but also of the conditions, socially and economically, which may have played a rôle in contributing to it. In other words, by example, this study is a lesson in scholarly thoroughness in the acquisition of information as opposed to the commonplace superficiality of knowledge which is all too prevalent.

One cannot study parts of history in any era and attain an adequate conception of what has taken place. The more erudite approach would be an attempt to learn something of all phases of man's activities during any given period. Undoubtedly, the historians might also benefit in the understanding and orientation of their subject of investigation if they too devoted more attention to all of the aspects of the period in which they are interested. This, for example, should include such medical matters as the effect of illness and death upon crucial decisions of monarchs or statesmen, and their effects on the morale and demeanor of the populace.

In many respects, the situation in historical research, and the evaluation of data pertaining to it, reminds me somewhat of the dangers inherent in highly developed medical specialism where, in some instances, members of our profession attempt to take care of parts of people. It is generally conceded that this procedure is fraught with danger.

No attempt will be made to review the contents of the entire book. I will, however, vouch for the statement that the subject is covered thoroughly in all of its aspects from neolithic times to the end of the nineteenth century. This includes such historical phases of miners' diseases as the morbidity and mortality, pathology and nosography, therapy and prophylaxis, and the beginnings of social and protective legislation. Certainly anyone desirous of obtaining a sound understanding of all diseases to which miners are subject should begin his studies with this treatise.

There were two individuals discussed in this book with whom I was not familiar historically, who especially attracted my attention. The first was Bernardino Ramazzini, an eminent Italian physician of Modena who lived between the years 1633 and 1714. In 1700 he published the first treatise on occupational diseases, *De morbo artificum diatriba*, which served two useful purposes: first, it summarized all knowledge on occupational diseases up to the eighteenth century, and second, it provided an excellent basis for future study. In addition to his knowledge of occupational diseases, Ramazzini must have been a clinician of considerable ability. At least he imparts some sound advice which, if followed more closely even today, would avert some diagnostic errors in medicine. He says . . . "when a physician visits a patient, he ought to inquire into many things by putting questions to the patient and the bystanders. You must ask . . . what uneasiness he is under, and what is the cause of it, how many days he has been ill; how his belly is affected and what food he eats," . . . to which I would presume to add one interrogation more: namely, "what trade is he of."

In perusing this monograph, one cannot help but admire also the work of J. Arnold who in 1885 published by far the most extensive study of experimental pneumoconiosis which had appeared up to that time. Although previous workers had contributed to this field, it was apparently Arnold who did the thorough job. In his attempts to produce pneumoconiosis in animals, he exposed rabbits to a dusty atmosphere for as long as eight hours daily, over a period of 417 days; in the case of dogs, the time of exposure was twenty-four hours daily for 806 days. His experiments did much to advance our knowledge in this field. It is amazing how often many clinical observations will be made concerning a disease and countless pages will be written dealing with the theoretical possibilities relating to its cause and mechanism of production, but so much time is required before someone has the initiative or insight to learn definite facts by attempting to produce the disease experimentally.

In conclusion, the reviewer makes the following comments: One should read Dr. Rosen's contribution to medical history (1) if he is interested in obtaining a thorough background for the study of occupational diseases and especially those associated with mining, (2) if he has an interest in medical history with its many

ramifications, and finally (3) if he has the desire to become acquainted with effective methods of research in topics dealing with medical history, and the presentation of the findings in an attractive and readable fashion.

CYRUS C. STURGIS

ROENTGEN TREATMENT OF DISEASES OF THE NERVOUS SYSTEM. By Cornelius G. Dyke, M.D., F.A.C.R., Associate Professor of Radiology, College of Physicians and Surgeons, Columbia University; Director, Department of Radiology, Neurological Institute of New York, and Leo M. Davidoff, M.D., F.A.C.S., Chief, Department of Surgery, Attending Neurological Surgeon, Jewish Hospital of Brooklyn. Cloth. Price, \$3.25. Pp. 198, with 12 illustrations. Philadelphia: Lea & Febiger, 1942.

The authors open their treatise with a discussion of the effect of radiations on the normal nervous system quoting evidence from the earliest experimenters. After presenting the general literature on the effect of roentgen and radium rays on pathologic nervous tissue, the techniques of Dr. E. P. Pendergrass, Dr. Sherwood Moore, Dr. M. C. Sosman, and Drs. Alexander Brunschwig and Anna Hamann are presented. This is followed by a detailed presentation of the authors' technique in the treatment of various pathologic conditions of the nervous system. Their results are then presented in detail. The world literature on the subject of irradiation of the nervous system is reviewed in this relatively small volume.

For anyone who is interested in the treatment of diseases of the nervous system by irradiation, the book should be extremely valuable, for it covers not only modern techniques but also the world literature on the subject.

H. DABNEY KERR

PHYSICAL FOUNDATIONS OF RADIOLOGY. By Otto Glasser, Ph.D., Professor of Biophysics and Head of Department of Biophysics, Cleveland Clinic Foundation, Cleveland, Ohio; Edith H. Quimby, Sc.D., Associate Professor of Radiology (Physics), College of Physicians and Surgeons, Columbia University, New York; Lauriston S. Taylor, Ph.D., Chief of X-Ray Section, National Bureau of Standards, Washington, D. C.; and J. L. Weatherwax, M.A., Philadelphia General Hospital, and Graduate School of Medicine,

University of Pennsylvania, Philadelphia. Cloth. Price, \$5.00. Pp. 426, with 95 illustrations. New York: Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, 1944.

The format of this book is excellent. Special attention should be called to the durable binding, neat, well arranged chapter headings and the position of the illustrations in close proximity to their descriptive material.

Subjects covered include a discussion of the concept of matter, roentgen-ray apparatus, character of the roentgen-ray beam as to quality and quantity with respect to both roentgenography and therapy. The last two chapters are concerned with radium dosage and protection methods for radium and roentgen rays.

A few fundamental equations necessary for basic understanding of the physics of radiology are stated in their simplest form with full explanation of each symbol and equation.

The book is a combination of text intended for beginners in radiology and tabulations of data suitable for the fully trained practitioner and advanced worker. It is inevitable that there is some conflict. As a compilation of practical, useful data—constants and numerical rules needed every day in a busy department and essential to any good teaching course—the book is invaluable and fills a need of long-standing.

H. S. HAYDEN

TECHNIC OF ELECTROTHERAPY AND ITS PHYSICAL AND PHYSIOLOGICAL BASIS. By Stafford L. Osborne, M.S., Ph.D., Assistant Professor,

Department of Physical Therapy, Northwestern University Medical School, and Harold J. Holmquest, B.S., B.S.(M.E.), Lecturer in Applied Physics, Department of Physical Therapy, Northwestern University Medical School, Chicago. Cloth. Price, \$7.50. Pp. 780, with 240 illustrations. Springfield, Illinois: Charles C Thomas, 1944.

Two men singularly equipped for the writing of a text dealing with the technic of electrotherapy and its physical and physiological basis have joined their efforts in the preparation of this book. Sixteen years of experience in the teaching of the subject matter at Northwestern University form the background of the method of presentation. The material is divided in four major chapters: direct current; muscle stimulation by electric currents; radiation, and high frequency currents. Each has appropriate subdivisions, usually starting with general considerations followed by thorough discussions of the apparatus used and of the technic of application of each therapeutic agent. The references to the literature are ample and the illustrations well chosen. One suggestion might be given for future editions. The spreading of footnotes over several pages sometimes separated by an interspaced illustration with legend—see pages 320-323 and pages 429-436—disrupt the continuity of the text. It would facilitate reading to have footnotes of such length incorporated in the main text. Otherwise the reviewer agrees with the last sentence in John Coulter's foreword: "It is indeed a book of fundamental worth."

ERNST A. POHLE



## DEPARTMENT OF TECHNIQUE

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Charleston, S. C.

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### TECHNIQUE OF ROENTGENOGRAPHY OF THE CONDYLES OF THE MANDIBLE

By MAJOR JAMES M. DELL, JR.

*Medical Corps, Army of the United States*

THE purpose of this article is not to present something new, but to emphasize the value of an old technique for roentgenography of the condyles of the mandible. This technique is particularly adapted to a study of the condyle, its articular surfaces, and adjoining ramus. The technique was described by W. W. McQueen in the

*Minneapolis District Dental Journal*, September, 1937, who used it in the study of the temporomandibular joint. Due to the direction anatomically of the temporomandibular fossa, this technique is not as valuable as the modified Law mastoid position. It has proved very valuable in the



FIG. 1



FIG. 4



FIG. 2

study of fractures involving this area as well as pathological changes in the articular surface of the condyle. The technique described by McQueen involves the use of a dental machine whereas the present tech-

nique uses the Picker Army Field Unit. As the field unit is widely available to the Armed Services it is thought that this technique may prove of some value.

The patient may be placed either in the



FIG. 3



sitting or recumbent position. The central ray is directed through the mandibular notch on the opposite side of the joint to be taken. The mandibular notch is best located at a point just below the zygomatic arch and about 2 cm. anterior to the posterior border of the ramus. The tube head is brought down almost to contact with the skin. An 8 by 10 inch cassette is placed on the side to be examined parallel to the sagittal plane of the head. The head is held in a true lateral position relative to the cassette. The central ray is directed 5 degrees posteriorly and 5 degrees superiorly

centering on the joint nearest the cassette. One exposure is made with the mouth closed and one with the mouth open. The articular surface is usually visualized better in the open mouth position.

Figure 1 illustrates the condyle with the closed mouth. Figure 2 illustrates the closed and open mouth positions. Figure 3 shows the open mouth position. Figure 4 demonstrates an apparent osteochondritis dissecans in the condyle. Several fracture cases were unavailable for reproduction. The illustrations show the structures that can be visualized by this method.



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## ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

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### ROENTGEN DIAGNOSIS

#### *Abdomen*

GUYER, R. B. The comparison of radiological and gastroscopic findings in 200 dyspeptic soldiers. *Brit. J. Radiol.*, 1943, 16, 241-246.

Dyspepsia has been a frequent cause of disability in soldiers during this war. The author reports the roentgen and gastroscopic findings in 200 cases in soldiers nineteen to forty-eight years of age. The technique of the two forms of examination is described and the findings in various pathological conditions of the stomach and duodenum compared. It was found that gastroscopic examination was the most useful in the diagnosis of gastritis. This is readily explained. The roentgenologist examines the stomach as a whole, and his diagnosis is based on estimation of function and examination of the coarser anatomical details. But the gastroscopist can make a close examination of the changes in the mucous membrane and see any early inflammatory changes that are taking place, as well as the more obvious organic lesions such as ulcer and malignant disease.

Roentgenology still stands supreme in the examination of the duodenum as this organ is inaccessible to the gastroscopist. Cases with duodenal ulcer gave normal gastroscopic findings in 50 per cent of the cases while in those with duodenitis only 1 out of 14 was normal. The finding of gastric changes on gastroscopy is therefore corroborative of the roentgen diagnosis of duodenitis rather than actually diagnostic in itself.

There are two other types of cases in which gastroscopy is extremely valuable: (1) cases of healed or healing gastric ulcer in which the changes have passed beyond the stage where they can be demonstrated roentgenologically, and (2) cases of early malignant disease in which the changes have not yet become pronounced enough to be demonstrated on roentgen examination.—*Audrey G. Morgan.*

JOHNSTONE, A. S. A radiological sign of pyloric stenosis. *Brit. J. Radiol.*, June, 1943, 16, 169.

Differentiation between true pyloric stenosis

and pylorospasm is often difficult. The best position for taking roentgenograms for this purpose is the supine with the left side slightly raised. It has been found that in roentgenograms taken in this way if there is stenosis of the pylorus there is a clearly defined shadow representing the thickness of the stomach wall along the greater curvature, the mucosa being lined with barium and the peritoneal surface showing as a fine line which becomes more noticeable if there is gas in the transverse colon. If the correct technique is used with a rotating anode, a moving grid and a kilovoltage slightly lower than that usually used with barium meals the shadow should be visible at some point along the distal two-thirds of the greater curvature in all cases of hypertrophy. Accurate measurement of the thickness of the wall cannot be made, but if the soft tissue shadows measure over 4 mm. hypertrophy is probable and if they measure over 5 mm. it is certain.—*Audrey G. Morgan.*

HODSON, C. J. A case of intestinal obstruction due to gallstones. *Brit. J. Radiol.*, June, 1943, 16, 185.

A woman past eighty with no history of abdominal symptoms was seized with violent abdominal pain, frequent vomiting and later collapse. A clinical diagnosis of obstruction of the small intestine by impacted gallstones was made. Roentgen examination showed four rounded, laminated shadows, two in the right hypochondrium close together and two in the right iliac fossa about 3 inches apart. It was thought probable that two of the stones were in the gallbladder and two in the lower ileum. They hardly seemed large enough to cause obstruction but it was thought that they might have a non-opaque cortex, which proved to be true. Laparotomy was performed the following day and the large stone at the lower end of the ileum removed. Later the others were passed naturally. The patient made an uneventful recovery.

The case shows the value of the plain roentgenogram in the diagnosis of serious abdominal conditions and also illustrates the variations in

opacity of gallstones and calls attention to the necessity of making allowance for this in such examinations.—*Audrey G. Morgan.*

BRILSFORD, JAMES F. The radiographic findings in idiopathic steatorrhea. *Brit. J. Radiol.*, Sept., 1943, 16, 283-285.

The condition known as idiopathic steatorrhea or non-tropical sprue is very similar to celiac disease of infants. It shows characteristic roentgen changes in the small intestine and bones and the clinical symptoms of hypocalcemia and avitaminosis. The clinical and roentgen findings indicate disturbances in the metabolism of fat and calcium.

The normal roentgenographic appearance of the small intestine is described, and roentgenograms given showing the normal intestine and that in steatorrhea and the changes in the bones of the hands in this disease.

In the small intestine the appearance of the jejunum is normal at first but within half an hour the normal appearance has changed and the barium as long as it can be seen in the small intestine seems to be gathered into curds, some small and irregular and others filling isolated dilated segments. In other places, curd-like fragments will be seen in segments dilated with gas. Some distended coils may show a coarsely serrated periphery, while others show barium in shallow folds of mucous membrane which pass around the segments in rib-like fashion. This irregularity in tonicity of the intestine may be associated with more rapid flow than normal; within two hours some of the barium may be seen throughout the large intestine, even though half the barium is still in the stomach. Much gas may be seen in the large intestine. The normal appearance in the beginning followed by abnormality though barium is still passing from the stomach suggests that the change in the barium pattern is caused by some excretion produced by the entrance of the food into the intestine, though the derangement of the innervation of the muscularis mucosa which is usually given as the cause may be an accompanying feature.

The bones in idiopathic steatorrhea show decalcification. In some cases the picture may resemble that of renal rickets or hyperparathyroidism. The metaphyses of the ends of the long bones are of greater depth than normal, the ends of the diaphyses being blurred as in rickets. In the adult, general decalcification may be associated with deposition of calcium in the ends of the phalanges. The skull of the adolescent

will show a fine, stippled osteoporosis while at a later age general decalcification may be associated with ill defined rounded islands of varying size and density; these islands do not occur in active hyperparathyroidism. The long bones bend under the weight of the body and incomplete fractures may appear on the convex surfaces. The bodies of the vertebrae tend to show disc compression on the upper and lower surfaces.

In the past the general physician has concentrated on the changes in the small intestine while the orthopedic surgeon has concentrated on those in the bones. An effort should be made to study the whole picture with the object of working out effective methods of treatment.—*Audrey G. Morgan.*

BAKER, JOEL W., and CARLILE, THOMAS. Solitary diverticulitis of the cecum. *J. Am. M. Ass.*, June 5, 1943, 122, 354-356.

This is a relatively rare condition which is occasionally encountered when the diagnosis of appendicitis has been made. Thirty-seven cases of solitary diverticulitis of the cecum have been found in the American and British literature. Two additional cases are reported by the authors. The essential pathologic process in each case was in a solitary diverticulum that was demonstrated to be acutely inflamed at operation.

The differential diagnosis of solitary diverticulitis of the cecum is almost impossible to make preoperatively. In a majority of cases in this series, a preoperative diagnosis of appendicitis was made. The differential diagnosis and choice of procedure at operation are of utmost importance in minimizing the risk to the patient. Aside from appendicitis, cancer is the most frequent lesion of the cecum. In differentiating cancer from diverticulitis, the problem is facilitated if one keeps in mind the three types of malignant tumors of the bowel. Tuberculosis is the next most frequently encountered lesion of the cecum. As a rule, the ileum also is involved. Small tubercles can occasionally be seen on the serosa. The peritoneum is usually thickened. Actinomycosis of the bowel usually starts in the cecum or the appendix. The wall may be greatly thickened, and in later stages small abscesses are formed which may open through sinuses in the abdominal wall, discharging the characteristic sulfur granules. Nonspecific ulcers of the cecum are encountered with approximately the same frequency as

diverticula. They may be single or multiple. The problem encountered is the same as that in diverticulitis. There should be minimal surgery rather than wide resection. Simple inflammatory tumors of the cecum in which there was no definite etiology have been reported.

In 14 cases in this series, resection of the cecum and/or ascending colon was considered advisable, either because of the extent of the lesion or because the lesion was thought to be malignant or tuberculous.—*S. G. Henderson.*

JENKINSON, E. L., and BROWN, W. H. Endometriosis; study of 117 cases with special reference to constricting lesions of the rectum and sigmoid colon. *J. Am. M. Ass.*, June 5, 1943, 122, 349-354.

The importance of this disease as a cause of constricting lesions of the rectum and sigmoid colon has not been sufficiently stressed, nor is adequate roentgenologic information available. Constricting endometrial lesions are often confused with carcinoma, and patients sometimes are subjected to radical resection of the bowel, whereas castration usually will suffice. The term "endometriosis" in this discussion designates islands of ectopic adenomatous tissue with histologic and functional characteristics similar to that of normal endometrium and located in the female pelvis outside the uterine wall and cavity. Endometriosis of the sigmoid colon or rectum resembles endometrial lesions elsewhere. Implants usually occur on the serosal surface with subsequent involvement of the muscular coats. The mucosa only occasionally is invaded. An associated intense inflammatory reaction is always present.

About 25 per cent of all women with pelvic endometriosis have lesions of the rectosigmoid. Since approximately 15 per cent of all women develop endometriosis, it may be concluded that from 2 to 4 per cent of all women at some time during their active menstrual life may develop endometriosis of the sigmoid, rectum or rectovaginal septum. At this site it is a potential factor in causing a constricting or obstructing lesion of the colon and rectum. Of the 47 patients with rectosigmoid endometriosis found in the present series, 21 had symptoms indicating some degree of obstruction.

Endometriosis of the rectosigmoid is characterized by symptoms similar to other forms of pelvic endometriosis and by gastrointestinal complaints which depend on the duration of the lesion and the presence or absence of a constrict-

tion. Most patients have a relatively long duration of symptoms. The average duration in the present series was 2.8 years. A high incidence of sterility is usually considered a characteristic of endometriosis and associated pelvic disease. In the present series 40 patients complained of absolute sterility. Menstrual abnormalities are frequently found. In the present series 95 complained of dysmenorrhea of the acquired type, metrorrhagia or menorrhagia. The most frequent complaint of the 21 patients with obstructive symptoms was severe progressive constipation usually associated with pain in the low abdomen which was worse at menstruation. There may be few significant physical findings, depending on the location and extent of the lesion. Sigmoidoscopic examination may reveal narrowing of the lumen of the bowel with intact but puckered red and congested mucosa. The intact mucosa explains the low incidence of gross or occult blood which would not be accounted for by other anorectal diseases.

The barium contrast enema has been considered by some writers to be of little value in the diagnosis of constricting endometrial lesions of the rectum and sigmoid colon. The presence of positive roentgenologic signs depends on the extent of bowel involvement and on the location of the lesion. Two factors probably produce obstructing lesions: (1) the endometrial tumor which may involve the bowel wall sufficiently to compromise the lumen, although the mucosa rarely is invaded; (2) the intense inflammatory reaction, which is the principal basis for the roentgenologic findings. In differentiating this disease from carcinoma, exacerbation of symptoms coinciding with the menstrual period is confirmatory evidence of endometriosis. Typical roentgen findings in endometriosis of the rectosigmoid include a long filling defect with sharp regular borders, intact mucosa, inconstancy of the filling defect and fixation of the bowel, which is exquisitely tender to palpation. Carcinoma is characterized by a short filling defect, sharp irregular margins, ragged, moth eaten mucosa, constant filling defect and usually absence of fixation or exquisite tenderness on palpation. Infectious lesions usually may be differentiated clinically.

The treatment of endometriosis of the rectosigmoid is summarized by Cattell, who emphasizes the importance of conservative treatment in patients under thirty-five. He states that radical treatment is necessary in most cases in which there is involvement of the colon and rec-

tum. Such cases, irrespective of age, require removal of both ovaries. Pemberton restricts roentgen therapy to patients in whom conservative treatment to preserve the childbearing function has failed. All patients in the present series with constricting lesions of the rectosigmoid caused by endometriosis, when examined by barium enema more than two months after surgical castration, had complete restoration of the lumen of the bowel.—*S. G. Henderson.*

ROBBINS, LAURENCE L. The roentgenologic diagnosis of parasternal omental hernia. *Radiology*, Oct., 1943, *41*, 378-382.

Three cases of parasternal omental hernia seen at the Massachusetts General Hospital are described and illustrated with roentgenograms. In two cases the hernia contained omentum only and, in the other, large intestine also. The roentgen image of omental hernia sometimes resembles that of mediastinal tumor. Differentiation is important not only for the sake of accuracy but because of the possible necessity for operation. The diagnosis of parasternal omental hernia can be made from a combination of upward displacement of the large intestine and the stomach and the presence of a mass in the right anterior cardiophrenic angle.—*Audrey G. Morgan.*

CONNOLLY, A. E. Endothelioma of the peritoneum. *Brit. J. Radiol.*, May, 1943, *16*, 153.

Primary tumors of serous membranes are rare. A case is described in a man of sixty-five first admitted to hospital June 29, 1937, complaining of abdominal pain and vomiting. Neither physical or roentgen examination showed evidence of tumor. He left the hospital free of symptoms after two weeks' treatment. He returned in November, 1941 complaining of abdominal pain, flatulence, loss of weight and vomiting. Roentgen examination showed gas-capped fluid levels in the intestine, as evidence of obstruction. Operation showed small secondary growths in the mesentery and small intestine. One such growth had caused complete obstruction at the lower end of the ileum. A lateral anastomosis was performed. The site of the primary growth was not determined. Recovery was uneventful. The clinical impression was that of carcinoma of the stomach with peritoneal metastases. The patient returned March 5 and roentgen examination indicated multiple obstructive lesions in the small intestine. Operation showed the mesentery, small bowel and great omentum covered with small white swell-

ings. In the first 3 inches of the jejunum there were three hard white infiltrated areas that caused obstruction. They seemed to start on the mesenteric border and extend around the loop. A posterior gastrojejunostomy was done. A part of the omentum was removed for examination, which showed dilated lymphatics and proliferation of the endothelium. Uneventful recovery.

The endotheliomatous growth apparently originated in the subserous lymphatics, and invasion of the lower ileum caused obstruction by gradual narrowing of the lumen. The clinical course indicated that the tumor was benign. It may, however, cause fatal results from mere size even though the cells are not malignant.—*Audrey G. Morgan.*

#### GYNECOLOGY AND OBSTETRICS

WILLIAMS, ROHAN. The radiological diagnosis of disproportion. *Brit. J. Radiol.*, June, 1943, *16*, 173-181.

Clinical examination of the pregnant woman should be supplemented by roentgen examination to determine whether there is any disproportion between the size of the fetal head and that of the fetus. This is particularly true in border line cases where there is any doubt from the ordinary obstetrical measurements.

The author describes in detail and illustrates a method of charting by means of two-projection reconstruction charts of the pelvis with which standard fetal head models are compared. The roentgenologist is particularly responsible for disproportion in the mid-plane and at the outlet of the pelvis. Sixteen cases are described and illustrated with charts. It is true, however, that it is impossible to calculate the force of uterine contraction, the capacity of the fetal head for moulding and the influence of the soft tissues on the flexion, extension and rotation of the fetal head and that therefore labor is often less difficult than would be indicated by the roentgen measurements.—*Audrey G. Morgan.*

ALLEN, E. PETER. The subpubic angle: radiological aspects. *Brit. J. Radiol.*, Sept., 1943, *16*, 279-282.

In view of the fact that the size of the subpubic angle is of definite obstetrical significance and a narrow angle causes delay at the pelvic outlet, it is a pity that so little is known of the roentgen measurement of this angle. Various techniques for the measurement of the angle

have been described but none of them is universally accepted. Some of the methods used have not been sufficiently described and illustrated and their use by anyone but the originator is apt to lead to mistakes. The errors inherent in various techniques have been unrecognized or their importance minimized. Until a standard technique has been adopted series of measurements made by different investigators cannot be compared and any series that have been made should be reviewed in the light of such standard technique.

The author recommends the preparation of a special roentgenogram by the method of Chasard and Lapiné which is described as follows by Roberts: "The patient is placed straddling a cassette . . . ; she is made to stoop forward till the under surface of the symphysis pubis and the ischial tuberosities are equidistant from the film, *i.e.*, the pubic arch is now horizontal. The tube is centred above or slightly posterior to the ischial tuberosities.' . . ." This roentgenogram should be checked by measurement of a standard lateral view of the pelvis and the measurement either of the subpubic angle direct or the measurement of the symphysis-biparietal distance by means of a transparency. If the angle is measured direct it should be measured as the angle made by two lines drawn from the lower edge of the symphysis tangential to the inner borders of the tuberosities.—*Audrey G. Morgan.*

#### GENITOURINARY SYSTEM

HODSON, C. J. Pyelography and the space-filling lesion; carbuncle of the kidney. *Brit. J. Radiol.*, March, 1943, 16, 86.

A case is described in a young man twenty-two years of age who had pain in the left loin, chills, sweats, leukocytosis and fever. The following week a trace of albumin was found in his urine. An intravenous pyelogram showed deformity of the left renal pelvis with lack of visualization of the middle calyx and a slight impairment of function as shown by dye tests. The roentgen examination alone suggested tumor but the clinical symptoms indicated acute inflammation and a diagnosis of carbuncle of the kidney was made. Treatment was given with rubiazol 1 gm. every four hours for four days followed by intensive sulfathiazole treatment for five days which brought his temperature down to normal. Recovery was uneventful. A second roentgenogram nine days after the first showed improved function of the kidney and

approximately normal anatomical conditions.

The case illustrates the importance of considering both roentgen and clinical findings in diagnosis.—*Audrey G. Morgan.*

PENDERGRASS, EUGENE P. Excretory urography as a test of urinary tract function. Carman Lecture. *Radiology*, 1943, 40, 223-246.

The author reviews the anatomy and physiology of the urinary tract, particularly the kidney and emphasizes the importance of correlating the kidney function tests and the urographic findings. The lecture is profusely illustrated with diagrams and roentgenograms illustrating the points he makes. It has been the custom for physicians and surgeons to think of excretory urography as a method of detecting pathological-anatomical anomalies in the kidney and to depend on the ordinary functional tests for information in regard to function. This is a great mistake and this form of examination should be considered essentially a functional test. Both tubular and glomerular function should be tested and there is some evidence that skiodan is more useful in testing glomerular function and diodrast in testing that of the tubules. The patient should be examined in the prone, erect, oblique and supine positions. Full details of the technique are given. The time required for clearance of the contrast medium is the test of kidney function. The ureters and bladder should also be included in the examination.

Urokinymography is one of the methods that will probably be developed further in the examination of the urinary tract.—*Audrey G. Morgan.*

ADAMS, PAYSON. Radiopaque membranous pyelitis following sulfonamide therapy. *J. Am. M. Ass.*, June 12, 1943, 122, 419-423.

Clinical and experimental reports of renal complications following the use of the sulfonamide drugs suggest their danger and the importance of meticulous observation. Sulfapyridine, sulfathiazole and, more recently and to a lesser extent, sulfadiazine are more prone to cause renal damage than is sulfanilamide. The slow absorption and relatively slow excretion and high solubility of sulfanilamide explain the infrequent occurrence of renal damage from this compound, whereas the very rapid absorption and excretion with resultant high concentration of the less soluble sulfapyridine and sulfathiazole in urine explain their relatively frequent production of renal complications. For the most



part, authors have indicated that sulfathiazole and sulfadiazine crystals precipitated within the renal pelvis and calices are highly soluble and will dissolve readily either under renal pelvic lavage with sterile distilled water through a ureteral catheter or spontaneously if the drug is discontinued and fluids are forced. Crystals precipitated within the renal tubules are not amenable to such therapy.

Two cases are cited in each of which partial or complete unilateral ureteral blockage by a small calculus was present. In each patient a radiopaque calcareous membrane formed on the epithelial surface of the calices and renal pelvis of the kidney on the involved side. Sulfathiazole in 1 patient and sulfadiazine in the other were thought to be at least partly responsible for this complication. Other factors, such as infection and obstruction, may have played a more important part, but similar cases have not been reported prior to the sulfonamide era.

The author concludes that sulfathiazole and sulfadiazine may cause rapid formation of a nonsoluble, calcareous, radiopaque membrane on the epithelial surfaces of the calices and pelvis if there is an associated ureteral stasis, pyelonephritis and alkaline urine. Therefore these drugs should not be given indiscriminately in such cases but, if thought mandatory, every effort should be made to prevent formation of such membranes by correcting ureteral stasis, maintaining renal drainage, improving the renal output and rendering the urine highly acid (pH 5.6 or less). —S. G. Henderson.

HARTUNG, WALTER, and FLOCKS, RUBIN H. Diverticulum of the bladder; a method of roentgen examination and the roentgen and clinical findings in 200 cases. *Radiology*, Oct., 1943, 41, 363-370.

Diverticulum is a frequent and serious complication of obstruction of the neck of the bladder. The nature, extent and seriousness of such complications can be determined only by roentgen examination. The authors describe a method of examination for such obstructions that consists essentially of four films: (1) the flat film; (2) the opaque anteroposterior cystogram; (3) the air cystogram taken in the oblique position, and (4) the cystourethrogram. This examination gives a great deal of information in regard to the bladder and urethra. The flat film shows the presence or absence of metastatic lesions in the bones and of opaque urinary calculi. The sodium iodide cystogram shows the pres-

ence or absence of diverticula, ureteral flux, displacement of the bladder, irregularity of the bladder wall and filling defects due to tumors or enlargement of the prostate. The air cystogram shows the presence or absence of non-opaque bladder stones, enlargement of the prostate and cancer of the bladder. The cystourethrogram gives more information in regard to the nature of the enlargement of the prostate and also shows the presence or absence of any pathological process in the urethra. The examination shows the size and position of any diverticulum of the bladder, the size of its neck, its contents and the ease with which the diverticulum can be emptied. It also shows the results of operative treatment of the diverticulum. Roentgenograms of typical findings are given and a brief summary of the roentgen and clinical findings in 200 cases of diverticula of the bladder. —Audrey G. Morgan.

COLSTON, J. A. CAMPBELL. Carcinoma of the prostate; study of percentage of cases suitable for radical operation. *J. Am. M. Ass.*, July 17, 1943, 122, 781-784.

In the five year period between September 1, 1937 and September 1, 1942, a diagnosis of carcinoma of the prostate was made in 358 cases, of which 318 were admitted to the hospital. During this period 73 radical operations were performed, this being 20.2 per cent of all cases seen. The criteria for cases suitable for the radical operation are not absolute. They depend largely on careful rectal examination. The malignant growth should not extend beyond the capsule of the gland, into the membranous urethra or beyond the base of the seminal vesicles, and metastases must not be demonstrable either on physical or on roentgenologic examination. In addition, the serum acid and basic phosphatase must be within normal limits. An elevated acid phosphatase level in the blood serum should be interpreted as indicative of metastases from prostatic carcinoma unless some other definite cause for this elevation can be proved. No patient should be subjected to the radical operation unless the general physical condition is satisfactory, and the patient should have a fair span of life expectancy. There were 4 hospital deaths in the series of 73 operations—a mortality of 5.5 per cent. Of 43 patients for whom the prognosis was good, 41 are living and well without evidence of recurrence or metastasis. Of 26 patients for whom the prognosis was poor, 8 are living and well at intervals varying

from three months to five years. Intensive follow-up of all patients with early cancer of the prostate subjected to Young's radical operation shows that more than 50 per cent are free from recurrence or metastasis from five to twenty-seven years after leaving the hospital.—S. G. Henderson.

#### SKELETAL SYSTEM

OSMOND, LESLIE H. Correlation of disability with roentgen findings: head injuries. *Radiology*, July, 1943, 41, 1-10.

Roentgenography of the skull, encephalography and ventriculography all help in demonstrating structural changes following trauma. Clinically, it is often difficult to determine what part is played in a disability by post-traumatic organic brain disease, post-traumatic neurosis or unrelated abnormalities. The methods mentioned above help to settle these questions, determine whether surgery is needed, establish a more accurate prognosis and show the degree of disability for which compensation can be claimed.

Roentgen examination immediately after a head injury is not always advisable; patients in shock should not be moved about on a roentgen table for fear of damage to the brain and intracranial blood vessels. The roentgen appearance of an old fracture may show evidence of sufficient pathology of the brain or meninges to explain varying degrees of disability. Other roentgen findings of significance are osteomyelitis, epidural and subdural hematoma, intracerebral hemorrhage, cerebral hemiatrophy with homolateral hypertrophy of skull and sinuses.

In the encephalogram injury to the brain following head wounds is shown by porencephaly, cerebral atrophy, arachnoiditis and scar formation. Porencephaly is the most characteristic change in brain trauma. Cerebral atrophy is somewhat less characteristic. All cases that the author has seen of porencephaly, unilateral cerebral atrophy and scarring of brain tissue have been associated with head injury except one case of bilateral internal porencephaly following a severe acute illness in infancy, but even in this case trauma could not be definitely excluded. The symptomatology in these conditions is not always in proportion to the structural change found.

Illustrative roentgenograms are given showing structural changes after head injuries.—Audrey G. Morgan.

BOVARD, PAUL. Correlation of disability with roentgen and clinical findings in silicosis: Part I. *Radiology*, July, 1943, 41, 11-12.

The author concludes that disability from silicosis cannot be determined accurately by roentgen examination alone, yet serial roentgenograms should be taken as an aid in such determination. A roentgenogram should be made before employing men in occupations in which there is a dust hazard and men should be rejected who have tuberculosis, emphysema or other conditions that might later be confused with silicosis. After a man is employed a record of illnesses, particularly those due to pulmonary conditions should be kept. Routine clinical examinations and roentgenograms of the chest should be made. The roentgen and clinical findings do not run parallel. There may be slight disability with severe changes, and vice versa. A part of the dyspnea in silicosis is due to fibrosis of the alveolus itself and not to nodular fibrosis. If alveolar elasticity can be increased the patient improves. When there is superimposed infection, particularly with tuberculosis, total and permanent disability may be expected. In a series of films there should be roentgen evidence of approaching disability. There seems to be need for closer cooperation between legislators and physicians in determining accurately the degree of disability in silicotics.—Audrey G. Morgan.

HANNOX, J. W. G. Correlation of disability with roentgen and clinical findings in silicosis: Part II. *Radiology*, July, 1943, 41, 13-17.

Disability in silicosis is due primarily not to the nodular fibrosis but to thickening of the walls of the alveoli and the associated emphysematous changes with decreased elasticity of the lungs resulting in interference with normal gaseous exchange. These changes occur before any fibrosis can be seen on the roentgenogram. Later, edema of the air sacs and terminal bronchioles and engorgement of the capillaries surrounding them contribute to the disability. The disability must be estimated, therefore, in terms of the decreased function of the lungs rather than by the amount of nodular fibrosis seen on the roentgenogram.

Methods of testing respiratory function are described and illustrated. When a normal person needs more air he gets it chiefly by increasing the depth of respiration. A person with respiratory disability can increase his depth of

respiration only to a very limited extent. When he needs more air he must increase his rate of respiration.—*Audrey G. Morgan.*

SCHUMACHER, FORREST L. Evaluation of disability in low back injuries. *Radiology*, July, 1943, *41*, 18-22.

Disability varies directly with loss or impairment of function. The most common industrial injury is simple muscle or ligamentous strain. Chronic strain is perhaps next in order; then rupture of a muscle or ligament. Any combination of these may occur plus involvement of joints.

Sometimes a diagnosis of sacroiliac sprain is made. This is generally due to old disease and not to the industrial accident. Another frequent mistaken diagnosis is arthritis aggravated by injury.

The end-result in low back injuries is manifested by limitation of motion and loss of strength. There must be some method of calculating these in the given case as compared with normal. Normal flexion and extension combined have a range of 130 degrees; if this is impaired 20 per cent and lateral extension 10 per cent Kessler says the greater impairment, or 20 per cent, should be considered the amount of the disability. If loss of lifting power is 10 per cent he still accepts the larger figure of 20 per cent as the degree of impairment.

McBride breaks up function into its component parts: quickness of action, coordination of movement, strength, security and endurance, to which he adds for industrial purposes safety as a workman and prestige of normal appearance in securing employment. The total of these components is 100 per cent. Each component is considered and its percentage noted; the sum total is the percentage of disability.

Either of these systems furnishes a sound working basis for computing disability.—*Audrey G. Morgan.*

BAKER, E. C. Correlation of disability with roentgen findings: the extremities. *Radiology*, July, 1943, *41*, 23-28.

By studying the roentgen findings in large series of cases it may be possible to work out correlations between clinical and roentgen findings on which prognoses can be based. This is a form of consultation which should prove increasingly useful to patients and referring physicians.

Three groups of cases are presented in which prognosis can be based on roentgen findings. In the fracture group tables are given showing what types of fracture carry the most unfavorable prognoses. Another group includes arthritic changes and pathologic conditions such as Charcot's joint which show that the patient has syringomyelia or syphilitic involvement of the spinal cord. There may be healing of bone and joint destruction and partial reorganization of tissue, but disability is permanent. The third group includes soft tissue injuries, including fluid about the joints, bursitis anterior to the patella, sprain fracture with swelling of the soft tissues around it and hemorrhage into the soft tissues. The author makes a special plea for more interest in the roentgen examination of soft tissue pathology on which prognosis may be based.—*Audrey G. Morgan.*

GOLDMANN, CARL H., and SMITH, STEPHEN J. X-ray appearances of bone in yaws. *Brit. J. Radiol.*, Aug., 1943, *16*, 234-238.

The authors discuss 101 cases of yaws proved clinically in which they made roentgen examinations. The patients were natives of Sierra Leone. The findings are illustrated with roentgenograms. Yaws is very similar to syphilis clinically and the Kahn reaction is positive in the blood. For the purposes of this paper the cases are divided into active and inactive.

The bone changes are most frequent in the tibia and next most frequent in the fibula. The fibula is rarely affected in syphilis. In active yaws the first roentgen signs are in the compact bone tissue, in contrast with syphilis in which they are in the periosteum. Yaws in the spinal column is infrequent and the patient presents the clinical picture of infective spondylitis. The affected vertebra is eburnated. In the clavicle, ribs and os pubis the affection is gummatous. Sequestra do not form, as a rule, and the periosteum is not usually affected. The clinical condition is extraordinarily mild in comparison with the roentgen findings. Specific treatment improves the disability within a few weeks.

The differentiation between syphilis and yaws is of great practical importance, for a soldier with yaws is worth keeping in the Army while one with syphilis is a very doubtful risk. Syphilis may imitate every picture of yaws but it is unusual for syphilis to attack the bone and leave the periosteum unaffected. Acute osteomyelitis must also be excluded. A patient with

the latter disease is very ill while one with yaws may be able to walk about. Yaws may of course be complicated by other infections. Osteitis deformans is quite common in Africa; it should be remembered in making this differentiation that yaws does not form sequestra. The roentgen findings in late yaws are very similar to those of Paget's disease which suggests that Paget's original idea that his disease is caused by a mild chronic infection may be true. Differentiation of tuberculosis from yaws may not be possible on roentgen examination alone. Generally there is much more extensive decalcification in tuberculosis than in yaws. There is a characteristic haziness in the picture of tuberculosis which is lacking in that of yaws. Clinically tuberculosis is a rapidly fatal disease in Sierra Leone while children with yaws normally improve. Joint lesions must sometimes be differentiated from yaws-arthritis. In yaws there is little decalcification and roentgenograms of the adjoining tibiae sometimes make differentiation possible. Avitaminosis is said to present a picture similar to that of yaws but decalcification is prominent and widespread throughout the skeleton. Yaws is frequently associated with avitaminosis.—*Audrey G. Morgan.*

BROCKLEBANK, J. A. The radiological appearances of bone in cases of tropical ulcer. *Brit. J. Radiol.*, Aug., 1943, 16, 221-224.

A series of cases of tropical ulcer in West African natives accompanied by roentgenological changes in the bones of the leg is discussed and roentgenograms given showing the nature of the bone changes. These tropical ulcers occur chiefly on the feet and lower part of the legs, and the roentgen changes are in the leg bones, chiefly the tibia. In about half the cases there were no bone changes, and the severity of the bone changes, or even their presence, showed no relationship to the size or severity of the ulcers. The earliest roentgen change was a local periostitis which advanced to a local osteoperiostitis and finally a pronounced osteomyelitis often affecting the whole of the diaphysis of the tibia. The epiphyses were not involved in any of the cases. Sequestra are almost always formed early and may involve the whole shaft. It is a striking fact that there is little deterioration of the general health in spite of advanced bone lesions. One man walked in for examination and half of the shaft of the tibia was found sequestered. In some cases the bones of both legs are

involved though there is a history of ulcer of only one leg.

The Kahn test was negative in these cases but it is often hard to make a roentgen differentiation from the bone lesions of yaws or syphilis. Gummatous syphilis shows less periosteal reaction in comparison to the bone destruction than the cases of tropical ulcer. In periostitis caused by *Bacillus coli communis* there are bone changes similar to those of these cases of tropical ulcer. The bacteriology was not studied in these cases.

The true etiology of tropical ulcer is not known so it is impossible to say whether the bone changes are the cause or the result of the ulcers. Possibly a dietetic factor or a sickle-cell lesion may be responsible for both ulcer and bone changes. In some of the cases in the above series it seems probable that the bone changes were caused by direct infection from the ulcers. The experimental production of osteomyelitis is easier when the vascular supply to the bone has been impaired. It is possible that tropical ulcer may impair the blood supply of the underlying bone and facilitate infection, or some general factor may cause such impairment of blood supply.—*Audrey G. Morgan.*

BRAILS福德, JAMES F. Avascular necrosis of bone. *J. Bone & Joint Surg.*, April, 1943, 25, 249-260.

Disturbance of the vascularity of bone by trauma, emboli, inflammatory, or neoplastic changes may result in avascular necrosis of the affected bone. Avascular necrosis becomes associated with osteoporosis of the adjacent bone and the phenomena known as osteochondritis, although it is not always a recognizable factor in the latter. Evidence of disturbance of the vascularity of a fragment of bone may be shown in the roentgenogram within six weeks of the application of the causal factor. Brailsford states that if the signs of osteochondritis develop in association with avascular necrosis, the necrotic fragment will be recognizable by its relative density throughout the whole period of reorganization which may be upwards of four years.

The point is stressed in this paper that the clinician should give due attention to the long period of bone plasticity in osteochondritis. Disregard of this is responsible for the deformities caused by stresses and strains on the inadequately immobilized joint surfaces. Avascular

necrotic bone shows a plasticity which persists over a similar period. Brailsford believes that osteochondritis presents a characteristic timetable. If the part affected is spared from stresses and strains during plasticity, regeneration is perfect.

He points out that the roentgenographic changes of Legg's disease and those following surgical trauma in reducing congenital dislocation of the femoral head, dislocation of the femoral head due to trauma, fractures of the femoral neck, and displacement of the femoral diaphysis from its capital epiphysis are not identical. They vary from complete restoration to complete destruction of the joint, although vascular necrosis may occur in many of these conditions. Roentgenograms, he asserts, do show evidence of pathological changes in the metaphysis of the upper femur in some cases before disintegration and displacement produce the lesion known as slipped epiphysis. Attention is drawn to the fact that recognition of this roentgenographic finding and prompt institution of protective measures may prevent the displacement and the consequences of avascular necrosis of the epiphysis. In Legg's disease the appearance of fragmentation is seen in the destructive phase, whereas in the case of surgical trauma it occurs in the regenerative phase. In the latter condition, the fragmentation resembles the ossification of the femoral head in hypothyroidism, but the epiphyses will not stand up to normal weight bearing and so are deformed, as are the epiphyses in Legg's disease, the difference being in that in Legg's disease the deformity occurs during disintegration rather than during reorganization.

Osteochondritis dissecans produces symptoms when the fragment becomes necrotic or displaced. The lesion may be recognized roentgenographically several years before this may happen. Temporary retention of calcium by a fragment of bone does not indicate that the fragment is necrotic. It may fuse without any of the secondary changes characteristic of necrotic bone. While avascular necrosis of bone can be detected roentgenographically by the greater density of a fragment which may also show friability associated with decalcification of adjacent bone, nevertheless hypercalcification of bone, Brailsford states, is not in itself an indication of avascular necrosis.

As long as the necrotic bone is present, decalcification and plasticity of adjacent bone will exist. This is an indication that necrotic bone in

traumatic cases should be removed as soon as detected, if for any reason the part cannot be efficiently immobilized until complete restoration can be detected roentgenographically.

Brailsford emphasizes the fact that the clinical signs and symptoms of disease usually disappear long before the plasticity of the bone. Treatment must therefore be regulated by the roentgenographic appearances and not by the absence of clinical signs and symptoms. Rest of the affected bone should be enforced as long as the roentgenograms suggest plasticity.—R. S. Bromer.

ENGEL, D. The etiology of the undescended scapula and related syndromes. *J. Bone & Joint Surg.*, July, 1943, 25, 613-625.

Engel states it is the purpose of this paper to widen the circle of the "bleb diseases" and to show that the undescended scapula and allied conditions are members of the same family.

A short outline of the bleb theory is as follows: Weed described the area membranacea at the roof of the fourth ventricle through which cerebrospinal fluid escapes to form the sub-arachnoid space. If for some pathological reason—such as the excessive production of spinal fluid, or its deficient reabsorption—or, perhaps in consequence of a primary disunion in the midline, the area membranacea remains unduly patent, cerebrospinal fluid escapes into the subcutis of the adjacent neck region. The subcutaneous blebs so formed spread on the body surface, and on their path exert a deleterious influence by pressure, and provoke an inflammatory reaction. They are driven by physical forces toward areas of least resistance, and are arrested and retained by preformed cavities and pockets, like the orbits or limb buds. It has been shown experimentally by Bagg and Little, and by Bonnevie that these blebs are the direct cause of manifold deformities in animals, such as club-foot, claw-hand, and polydactylism. Deformed second and following generations of mice which had not been irradiated, produced progeny affected, in a high proportion of cases, by the same malformations. The acquired anomalies thus proved to be inheritable. Blebs, such as described by Bagg in his strain of mice, were also observed in human embryos by Bonnevie and were associated with anomalies of fingers and toes.

Engel believes that by classing the three syndromes, namely, Sprengel's deformity, Klippel-Feil syndrome, and symbrachydactylia, among

the bleb diseases, a further group of deformities has been brought nearer to understanding. The evidence given in favor of this view is at the same time a further support of the bleb theory in general. He believes that this theory has a greater scope in the pathology of malformations than is generally known.

Engel's reason for singling out these three syndromes from a larger group is their localization around the shoulder girdle. The Klippel-Feil syndrome is characterized by shortness of the neck caused by abnormalities such as fusion and reduction in the number of the vertebrae, with secondary scoliosis or kyphosis and restricted head-neck movements; low implantation of the hairline; frequently webbed neck caused by stretching of the trapezius; an elevated scapula; torticollis of osseous or muscular origin; disproportion between the length of the extremities and the trunk; and descent of the nipples.

Symbrachydactylia is characterized by shortness and other anomalies of the fingers, combined with syndactylism. It affects principally the upper, and hardly ever the lower, extremities. The nails are often abnormal, and the radius is sometimes missing. The association with undescended scapula, defects of the ribs and clavicle and anomalies of the mamma are very frequent. It is also of great interest that the skin between the arm and thorax is often webbed, a feature frequently seen in bleb diseases.

Engel discusses the arguments in favor of the bleb theory, in which the primary cause of the deformities is an inherent quality in the embryo itself, and points out the arguments against the explanation of the deformities on an exogenous basis such as pressure by the womb or amnion. One of the strong arguments in favor of the undescended scapula being one of the bleb diseases is the fact that it constitutes one of the signs of dysostosis multiplex which belongs to the bleb disease group. In a high proportion of these cases an undescended scapula was recorded and explained by the bleb mechanism.

The 2 cases recorded in the literature by Horwitz and Bizarro are the only ones which so far have come to Engel's attention as giving unmistakable direct evidence of a "bleb" in the neck region. If it is considered that the cases of undescended scapula are brought to the surgeon usually several months or years after birth, it will be understood that "lumps" in the neck of transitory character are frequently overlooked,

and if observed, they are very likely to be mistaken for a cephalhematoma. The question of whether any direct sign of a bleb in the neck region of patients affected by undescended scapula has ever been reported can thus be answered in the affirmative.—*R. S. Bromer.*

HARTLEY, J. BLAIR. "Stress" or "fatigue" fractures of bone. *Brit. J. Radiol.*, Sept., 1943, 16, 255-262.

Stress or fatigue fracture of bone is not very well understood though march foot has been recognized and reported since 1855. The fatigue fractures considered here are due to the same causes as march foot, but they occur most frequently in the tibia, particularly in the upper third. A strict differentiation must be made between these fractures and pseudofractures occurring at Looser's transformation zones, or pathological fractures occurring in any disease of bone, such as Paget's disease, diseases due to avitaminosis or bone tumors. A table is given showing the differences between stress fractures and pseudofractures.

The first and outstanding symptom is pain which almost always subsides when adequate rest is given. It is not sufficient to put a soldier on light duty or excuse him for a little while; prolonged rest from weight bearing is necessary and it may be necessary to supplement this with plaster. The characteristic roentgen finding is callus formation. These calluses generally appear at points where there is an overload, as for instance in the posteromedian aspect of the tibia where the "axis of vertical stress" through the internal condyle cuts the cortex. In some cases a crack or definite fracture line can be demonstrated, usually about three weeks after the onset of symptoms. Pathological fractures in bone tumor occur relatively late. The findings may be bilateral and symmetrical or bilateral and asymmetrical.

Rapid organization of callus, the formation of a zone of sclerosis and rapid healing of the fracture are of good prognosis and generally occur if adequate rest is given. If a transverse zone of osteoporosis extending across the bone develops the prognosis is bad. It shows that overstress has persisted too long after bone fatigue began and recovery will be slow, taking months instead of weeks, and there is danger of complete fracture.

Some authors believe the condition is due to nutritional deficiency but the author believes that the chief if not the only factor is a dispro-



portion between what is required of the bone and its inherent capacity to bear stress. He believes that now that the younger age groups are being called to the fighting forces and as a result of high-pressure training of Commando units and possibly of parachute training many more cases will appear and much will be learned about the condition.

The treatment is rest. Early cases of bone neuralgia require only a few day's rest without immobilization. The more severe cases with periostitis or actual bone fatigue require more prolonged rest with immobilization and more gradual resumption of weight bearing. Very severe cases will require immobilization in plaster for weeks or months and very gradual return to normal weight bearing.

Mistaken diagnosis may lead to recurrence or involvement of the opposite leg or complete fracture of tibia and fibula, or to unnecessary operation for suspected bone infection and even to threatened amputation. Correct treatment is simple and always brings about recovery. The condition may be caused by Army service and lead to claims for compensation.

The author suggests the use of radioactive indicators in detecting any deviation from normal replacement in fatigue fractures and in determining whether bone exhaustion disturbs or delays normal replacement.—*A. G. Morgan.*

SWEET, HOWARD E., and KISSER, WENDELL H. March fractures. *J. Bone & Joint Surg.*, Jan., 1943, 25, 188-192.

The authors agree with Meyerding and Pollock that march fractures are the result of overloading of a foot already weakened functionally and anatomically. The bone lesions in their series of cases in the Army service were incurred while the patients were undergoing strenuous marches with considerable overloading of feet that were probably already weakened.

The earliest change noted in the roentgenograms of their patients was a thin, transverse, hair-line fracture through the cortex of the metatarsal bone. At times this was so faint that it was necessary to use a reading glass to visualize the fracture. They found it not uncommon in the early stages of the lesions to find a nor-

mal-appearing bone in the roentgenograms. Later ones showed a crack transverse fracture with beginning callus formation. Still later roentgenograms showed a spindle-shaped mass of callus surrounding the fracture. Occasionally, in advanced cases, there was only a mass of callus with no fracture line visible.

A history of insidious pain in the foot, which is progressive, and is relieved by rest, and within twelve to twenty-four hours is associated with edema of the dorsum of the foot should suggest march fracture. There is tenderness over the involved bone.

The treatment followed in their cases was immobilization of the foot in a plaster boot for a period of four to eight weeks, depending upon the roentgenographic finding of adequate callus formation. Following removal of the plaster boot, the patient was given one to two weeks of rest and physiotherapy and was then returned to full military duty.—*R. S. Bromer.*

CHILDRESS, H. M. Fracture of a bipartite carpal navicular. *J. Bone & Joint Surg.*, April, 1943, 25, 446-447.

Childress reports a case of a fracture of a bipartite carpal navicular. The roentgenograms of the right wrist were made in four positions. One view was interpreted as an old fracture of the carpal navicular with traumatic arthritis between the fragments. Also, the distal portion appeared to be rotated 90 degrees clockwise. Because of these unusual findings, a roentgenogram was made of the left wrist of the patient and the left navicular was found to be bipartite. Ten years previously the patient had injured his wrist in much the same fashion as the recent trauma and the original roentgenograms were obtained. They showed the right navicular to be bipartite, and its distal fragment to be fractured. The abnormal appearance of the distal portion in the recent roentgenogram was due to malunion, and not to rotation as was first believed.

This case is reported because of its rarity and because it illustrates well the value of checking unusual bone findings in an extremity with roentgenograms of the opposite normal one.—*R. S. Bromer.*



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1. Gardner, W. J., and Frazier, C. H. Ventriculography without air injection. J. Am. M. Ass., 1929, 93, 193-194.

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## MYELOGRAPHY BY THE USE OF PANTOPAQUE IN THE DIAGNOSIS OF HERNIATIONS OF THE INTERVERTEBRAL DISCS\*

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### INTRODUCTION

NUMEROUS clinical studies have been made during the past ten years concerning lesions of the lumbar intervertebral discs. More recently, interest has been aroused in protrusions of cervical intervertebral discs, largely through the work of Semmes and Murphey<sup>7,8</sup> and Spurling and Scoville.<sup>10</sup> However, the rôle of myelography in the diagnosis of intervertebral disc herniations is still controversial. Many workers in this field have not made use of contrast media routinely because of alleged irritation by the substances employed or of difficulties in performing myelographic examinations and in interpreting findings. Also a hesitancy has been manifest to the injection of a medium which may remain for years in the subarachnoid or epidural space, providing a possible basis for prolongation of symptoms after the original lesion has been removed.

The purpose of this report is to relate our

experience with the use of a recently introduced contrast medium, pantopaque. This substance was developed by Strain, Warren and their associates.<sup>11,12</sup> The study is based upon a series of 129 myelographic examinations performed at the Halloran General Hospital. In this group, 77 patients were operated upon and all data available, clinical, roentgenological, surgical and pathological, have been studied. The technique of lumbar and cervical myelography with pantopaque is described and conclusions are presented regarding the significance of myelographic findings and the value of the procedure in the diagnosis of herniations of intervertebral discs. Pantopaque is compared with other agents as a contrast medium for myelography.

### TECHNIQUE FOR LUMBAR MYELOGRAPHY

The technique for introduction and removal of pantopaque is substantially the same as that described by Kubik and

\* From the X-Ray Service and Neurosurgical Section of the Halloran General Hospital, Staten Island, New York.



FIG. 1. Patient in position for lumbar or cervical myelography; needle inserted at third lumbar interspace. Note wooden brace attached to fluoroscopic arm to prevent screen from touching needle during roentgenoscopy.

Hampton<sup>1</sup> for lipiodol myelography.

The patient lies prone on a roentgenoscopic tilt-table equipped with a spot film device, his feet braced against the foot rest, a rolled pillow under the abdomen to arch the lumbar spine (Fig. 1). The head of the table is elevated about 10 to 15° above horizontal. Under ordinary aseptic precautions, a No. 18 gauge spinal needle is inserted at the third lumbar interspace, care being taken to make a central puncture. The third lumbar interspace is chosen (even though subsequent removal is slightly more difficult) because of the relative infrequency of herniations at this level. Since most lumbar disc herniations occur at the fourth or fifth interspace, a false defect due to a needle puncture at these levels is avoided. After ascertaining that the needle is within the subarachnoid space, 3 cc. of pantopaque is injected slowly; the obturator is replaced, and the area is covered with a sterile towel. The pillow is removed from beneath the abdomen and placed under the patient's legs.

The fluoroscopic screen is drawn into place and a supporting bar of wood is placed under the arm of the screen to prevent it from dropping and hitting the needle. Bars of several different lengths should be available for use with patients of varying size.

By tilting the table the pantopaque is allowed to flow from the caudal sac to the highest level under study. The pantopaque should be passed over any suspicious area several times. Filling of the nerve root sheaths is facilitated by rolling the patient slightly from side to side. Any lag, delay or deviation in the course of flow of pantopaque should be observed.

As noted by Copleman,<sup>1a</sup> the head of the column should be scrutinized carefully in the anteroposterior and oblique projections, as small central defects may otherwise be overlooked.

If the spinal canal is unusually wide or if doubt exists as to the demonstration of a lesion, an additional 3 cc. of pantopaque may be injected.

The range of motion of the tilt-table is sufficient to allow for study of the lumbosacral canal of the average patient. Occasionally it is necessary to place a pillow under the pelvis in order to tilt the spine sufficiently to fill the upper lumbar canal. The same effect can be produced by having the patient elevate his pelvis several inches from the table, care being taken that the needle does not hit the fluoroscopic screen.

Spot roentgenograms are taken of each lumbar disc. The pantopaque then is pooled opposite any suspicious area and a posteroanterior Bucky roentgenogram is taken on a 10 by 12 inch film (Fig. 6). This



FIG. 2. Pantopaque is pooled in cervical canal. Full extension of neck prevents pantopaque from entering skull.

larger film gives a reverse projection of the canal from that observed roentgenoscopically and offers added evidence regarding the area under study. It is also useful to the surgeon as it outlines the defect in relation to the lower spine. Oblique and lateral projections are of help in occasional cases. The latter are produced by directing the coned rays laterally through the spine with the patient lying prone on the table, the pantopaque pooled opposite the area under study. A wafer grid over the cassette improves detail.

Following completion of study, the pantopaque is pooled about the needle point under roentgenoscopic control and is withdrawn by gentle suction. If a nerve root is drawn against the needle point thus producing pain, rotation of the needle usually will move it away. Occasionally it is necessary to insert a second needle at the fourth or fifth disc level where the pantopaque is withdrawn more readily than at the higher interspaces (Fig. 7).

#### TECHNIQUE FOR CERVICAL MYELOGRAPHY

The patient lies prone on the tilt-table in the same position as for lumbar myelography. Due to the fact that most roentgenoscopic tables have a limited downward excursion of the head of the table, it is necessary to elevate the patient's pelvis.



FIG. 4. Bolster has been removed and table tilted nearly to vertical to allow pantopaque to return to lower canal.

This can be done quite effectively by placing a bolster under the patient's abdomen. A simple bolster can be made by rolling two or more pillows tightly together and tying a string or bandage about them.

Six cubic centimeters of pantopaque are injected into the subarachnoid space at the fourth or fifth lumbar interspace, the lower level being preferable to an upper because of the greater ease of subsequent removal.

The patient holds his neck in full extension, thus preventing the pantopaque from entering the cisterna magna (Fig. 2). The fluoroscopic screen is drawn into position, the room darkened and the table tilted so that the pantopaque flows toward the cervical region. As soon as the examiner observes all of the pantopaque in the cervical canal, the table is tilted back to horizontal position. Since in this position the cervical canal is at a slightly lower level than the thoracic canal and the cisterna magna, the pantopaque remains in this position. The patient may then drop his chin slightly so that the base of the occiput and inferior border of the mandible are superimposed on the roentgenoscopic image, thus allowing for more satisfactory visualization of the cervical canal. Slight tilting of the table upward and downward will distribute the pantopaque evenly through the canal.

In this area the pantopaque is spread more thinly than in the lumbar region.

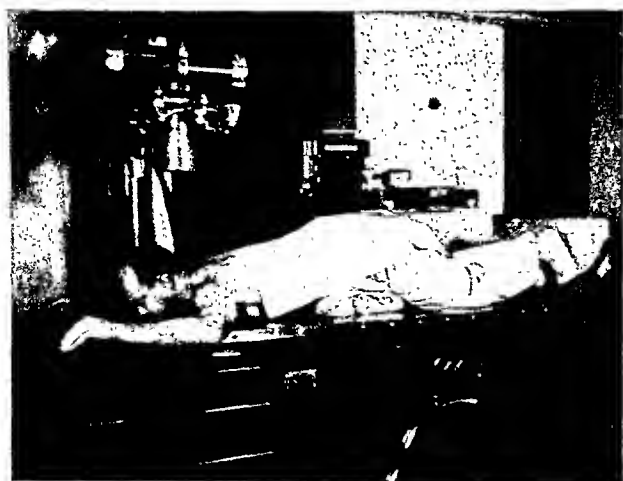


FIG. 3. Overhead tube, Bucky and patient in position for roentgenography. The base of the occiput and the inferior border of the mandible are in a plane perpendicular to the table top.



FIG. 5. Normal lumbar myelogram (spot roentgenogram) following injection of 3 cc. of pantopaque through needle at third lumbar interspace. Outline of upper canal as copied from other roentgenograms of the same patient appears above the column of pantopaque.

Consequently the shadow is less homogeneous. However, the nerve root sheaths are demonstrated clearly and defects, when present, are fairly obvious. As in lumbar myelography, it is advisable to allow the pantopaque to flow over the suspected area several times to be certain that any defect noted is constant and represents an actual fixed deformity.

Occasionally the pantopaque will break up into small globules which fail to coalesce. This is less likely to occur if the medium flows smoothly and evenly over the dorsal curve. Small root defects may not be detected if so-called "globulation" is present but large defects are not obscured.

In this region posteroanterior Bucky

roentgenograms are superior to spot roentgenograms (Fig. 40). Use of a small focal spot is desirable and a rotating anode tube will give especially fine detail (Fig. 3).

Since most cervical disc lesions involve the sheaths of the sixth or seventh cervical roots which enter above the corresponding cervical vertebrae, it is rarely necessary to visualize the upper canal. However, this may be done if desired by projecting this portion of the cervical canal through the open mouth, using a technique similar to that commonly employed for demonstration of the odontoid process.

Following completion of study, the bolster is removed from beneath the patient's abdomen and the table is tilted to a nearly vertical position (Fig. 4), thus causing the pantopaque to return to the lower canal. The skull and upper spine should be examined carefully with the roentgenoscope to be certain that no droplets are present in these areas. The pantopaque is then pooled under the needle point and removed.



FIG. 6. Ten by twelve inch posteroanterior roentgenogram outlines the column of pantopaque with its relations to the lumbosacral spine.

## TECHNIQUE FOR THORACIC MYELOGRAPHY

While posterior protrusions of intervertebral discs are infrequent in the thoracic region, this area is occasionally studied myelographically for evidence of other lesions. A technique similar to that employed for cervical myelography is satisfactory for most cases. Occasionally it is advisable to use 9 cc. of pantopaque and to withdraw the needle so that the patient may be roentgenoscoped in the supine position. In such cases, after all studies have been completed, a needle is reinserted at the fourth or fifth lumbar interspace and the pantopaque is withdrawn.

## ANALYSIS OF MATERIAL

Myelography was employed as a diagnostic procedure in 129 patients, pantopaque being the contrast medium used in



FIG. 7. Complete removal having been impossible by aspiration at the third interspace, a second needle was introduced at the fifth interspace. One small drop of pantopaque remains.



FIG. 8. Case J. T. The right fifth lumbar root defect was overlooked prior to operation. A lateral protrusion was found.

118, lipiodol in 11. In this group, 77 patients were operated upon.

In the cases with positive myelograms, the nature of the lesion was predicted in all but two. In one case (Fig. 13) a herniated left lumbosacral disc was diagnosed whereas at operation an extradural metastatic tumor was found. In the other case, a cervical cord tumor was suggested by the myelogram (Fig. 14) and also by clinical studies; at operation, a herniation of the intervertebral disc was found between the sixth and seventh cervical vertebrae on the left side with extensive arachnoidal adhesions.

In 64 of the 77 patients the site or sites of lesions were predicted correctly by myelographic examination; in each of 8 additional cases, the major herniation was identified by myelography but additional



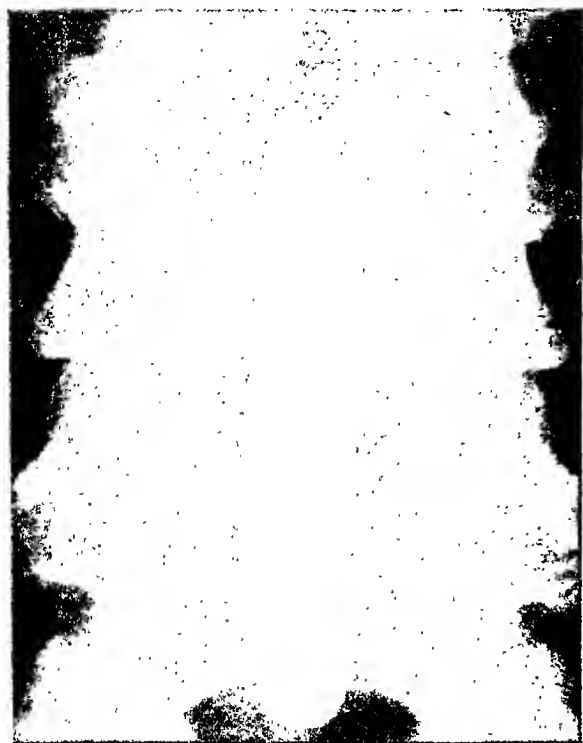


FIG. 9. Case E. L. Narrow canal with under-developed nerve root sheaths.

slight defects were noted myelographically which were not found at operation to be due to protrusions. In some of these cases the secondary defects were apparently due to arachnoidal adhesions or hypertrophy of the ligamentum flavum; in others, the cause of the defects could not be determined.

Of the 5 remaining cases, the myelogram in one was reported as normal; subsequent review of the myelograms showed a definite minimal defect of the nerve root sheath at the site of the lesion (Fig. 8). One patient had an unusually narrow canal with poorly developed nerve root sheaths (Fig. 9, and 10); although no defect was visible in the opaque column, a moderately large protrusion was found compressing the left fifth lumbar nerve root distal to the arachnoidal extension of the sheath. Each of the other 3 patients had apparent high terminations of the caudal sac, at or above the level of the fifth lumbar disc without perceptible defects in the opaque column or nerve root sheaths. In each of these 3 cases a large

protrusion of the fifth disc was found (Fig. 11 and 12.)

#### TYPES OF DEFECTS

I. "Block" defect from complete obstruction usually produced by a large midline protrusion. The only cases observed in this series were the 3 patients noted above with apparently high terminations of the caudal sac from midline protrusions of the fifth lumbar disc. A roentgenogram of a patient studied by one of us (S. W. G.) in 1937 demonstrates a complete block opposite the second lumbar disc (Fig. 15). Clinically, it is difficult and often impossible to differentiate such lesions from spinal cord tumors. Complete blocks except at the level of the fifth lumbar disc are uncommon; in a



FIG. 10. Same case as in Figure 9. At operation, a large protrusion was found compressing the left fifth lumbar nerve root.

series of more than 200 cases observed by one of us (S. W. G.) and a series of 75 cases studied by another of us (A. B. S.), only 2 such cases were encountered. With a complete block none of the contrast medium passes the site of obstruction, but if pantopaque or lipiodol is introduced above and below the area of block the limits of the obstructing lesion can be determined.

2. "Gap" defect from incomplete obstruction, also usually produced by a large midline protrusion. In this type the pantopaque forms two pools, one above and one below the lesion. On roentgenoscopy the contrast medium is seen to pass slowly over the lesion, drop by drop, usually lateral to the midline. "Gap" defects were present in 4 cases (Fig. 16, 17, 18 and 19); in each, a large herniated disc was found and removed at operation.

3. "Veil" defect. In this type, also caused

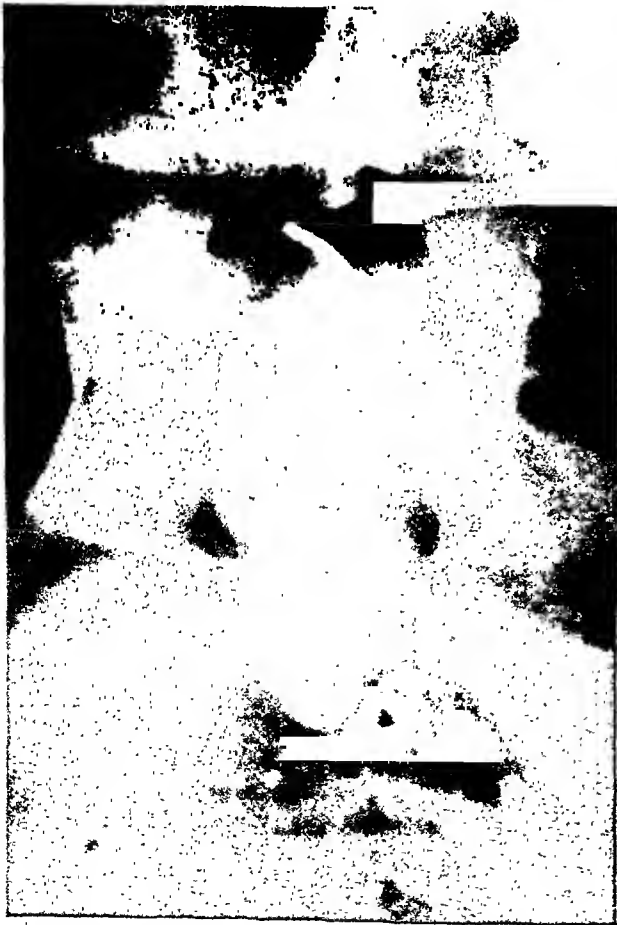


FIG. 11. Case V. G. Spot roentgenogram with patient standing demonstrates apparent high termination of the caudal sac.



FIG. 12. Same case as in Figure 11, lateral roentgenogram. At operation a complete herniation of the fifth lumbar disc was found.

by a midline herniation, the contrast medium is of decreased density at the site of the lesion due to thinning of the opaque column opposite the protrusion. Myelograms of this type were found in 4 cases, of which Figure 20 is a typical example.

4. "Hour-glass" defect usually due to a bilateral herniation of a disc. This type of defect requires careful scrutiny. If there is a symmetrical defect between two pairs of normal roots or axillary pouches, it is probable that the constriction is due to a slight bulge of the disc or to osteophytes about the margins of the vertebral bodies and not to an actual herniation. False defects of the "hour-glass" type are also apt to be multiple. In a true "hour-glass" defect due to a herniation of an intervertebral disc, there is fusiform constriction of the canal with shortening, elevation, distortion or obliteration of the nerve root sheath or sheaths at the level of the herniation. Defects of this type were found in 5 cases in which exploration confirmed the myelo-

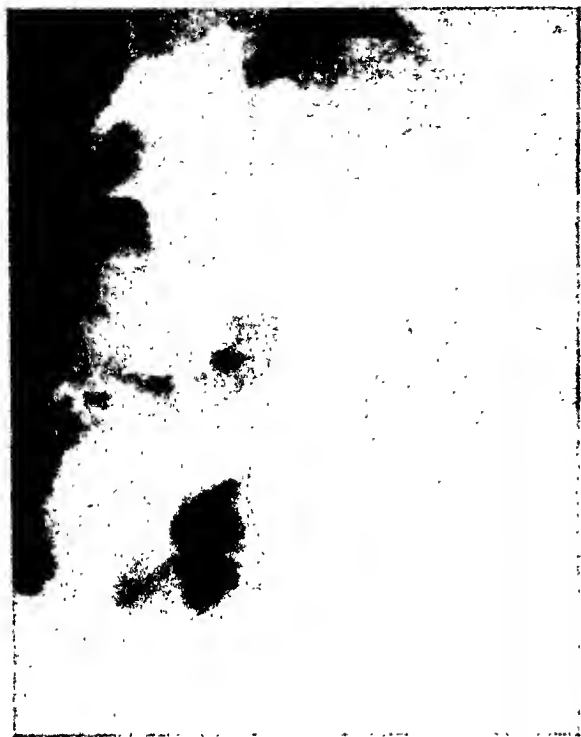


FIG. 13. Case D. S. The lateral fourth lumbar defect was interpreted as a disc protrusion. An epidural tumor was found at operation.

graphic diagnosis (Fig. 21, 22, 23, 24 and 25).

5. "Lateral pressure" defect from lateral herniation of a disc. This is the type encountered most frequently. The appearance is that of a smooth, rounded defect or notch on one side of the column. These defects



FIG. 15. Complete block opposite the second lumbar disc demonstrated with lipiodol (case not in this series).

vary in size but are always accompanied by shortening, amputation or distortion of the nerve root sheath on the side of the lesion. Twenty-one large lateral defects and twenty-four small lateral defects were present in this series. A defect was considered large

FIG. 14. Case F. F. An extramedullary tumor was suspected opposite the sixth and seventh cervical vertebrae; a large cervical disc herniation was found between these two vertebrae associated with extensive arachnoidal adhesions.



FIG. 17. Case F. J. "Gap" defect from large midline protrusion.

if it was at least one-third of the width of the column. Figure 26 is an example of a huge lateral defect. Figures 27 and 28 illustrate other large defects and Figures 29 and 30 demonstrate small lateral defects.



FIG. 16. Case B. G. "Gap" defect produced by large right fifth lumbar disc protrusion. During roentgenoscopy, pantopaque was seen dripping from one pool to the other.

It should be noted that the size of the defect in a myelogram is not always an index of the size of the protrusion. A large defect indicates a large herniation. On the other hand, a small defect does not necessarily mean that a lesion is small, especially at the lumbosacral level or if the canal is narrow. Under these circumstances, most of the protrusion may lie under the root in its extradural course after it leaves the dural sac. Figure 29 demonstrates a very small lateral left fifth lumbar defect with a shortened nerve root sheath; on exploration a large lateral herniation was found.



FIG. 18. Case J. K. "Gap" defect.



FIG. 19. Case P. D. "Gap" defect.

6. "Root" defect from lateral herniation of a disc, compressing the nerve root sheath without obtruding upon the subarachnoid space of the spinal canal. Abnormalities in the filling of the nerve root sheaths not associated with any other abnormalities in



FIG. 20. Case D. S. "Vell" defect from midline protrusion of fourth lumbar disc.



FIG. 21. Case J. R. "Hour-glass" defect from large protrusion which distorted bases of the nerve root sheaths.

the column were found in 21 cases. In 10 cases there was complete failure of filling or "amputation" of the nerve root sheath. In 11 cases the nerve root sheath on the side of the lesion was shorter than the one on the opposite side. The roentgenogram reproduced in Figure 31 is a typical example of amputation of a nerve root sheath on the side of a herniated disc. In Figure 32,

the nerve root sheath was shortened and elevated on the side of the lesion while the one on the opposite side was of normal appearance.

#### MULTIPLE HERNIATIONS OF LUMBAR INTERVERTEBRAL DISCS

In 11 patients two herniated lumbar intervertebral discs were found at operation; in every case the correct diagnosis was pre-



FIG. 22. Case R. H. "Hour-glass" defect; midline herniation was found at operation.

dicted from the myelogram. In 6 cases, both herniations were on the same side at the fourth and fifth lumbar discs. In 2 cases, the herniations were on the same side at the third and fourth lumbar discs. In 2 cases, the herniations were in the midline at the fourth lumbar disc and on the left side at the fifth lumbar disc. In one case, the herniation was on the right at the fourth lumbar disc while at the fifth lumbar disc it was on the left (Fig. 33). In this patient, an Italian Service Unit Trainee, the clinical signs pointed to the left fifth lumbar disc as the site of the lesion. Both discs were ex-



FIG. 23. Case J. M. "Hour-glass" defect from midline herniation.



FIG. 24. Case D. P. Nearly complete "hour-glass" defect.

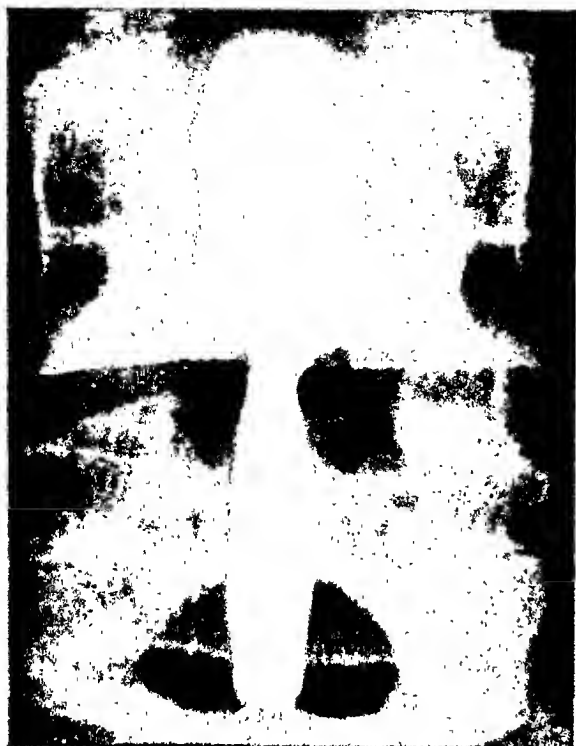


FIG. 25. Case J. E. "Hour-glass" defect.

plored and large herniations found at both levels. A large tear was found in the annulus of the fourth lumbar disc with extrusion of disc material into the spinal canal.



FIG. 27. Case F. K. "Lateral pressure" defect.

Other examples of double disc herniations are illustrated in Figures 34, 35 and 36.

#### RECURRENT HERNIATIONS

Myelography was carried out in 3 patients who continued to complain of pain months after herniated discs had been removed. In 2 cases who had had their orig-

FIG. 26. Case G. M. Huge "lateral pressure" defect: a large fourth lumbar protrusion was found free in the canal.





FIG. 28. Case P. C. Left lateral fifth lumbar protrusion producing "lateral pressure" defect.

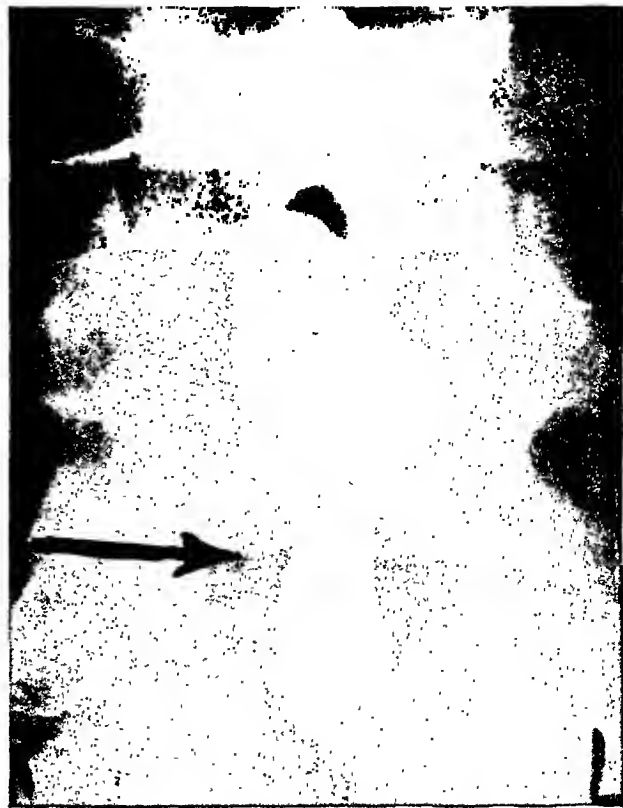


FIG. 30. Case R. R. Small "lateral pressure" defect, fourth lumbar, right.



FIG. 29. Case R. F. Small "lateral pressure" defect, fifth lumbar, left; a large lateral herniation was found at operation.

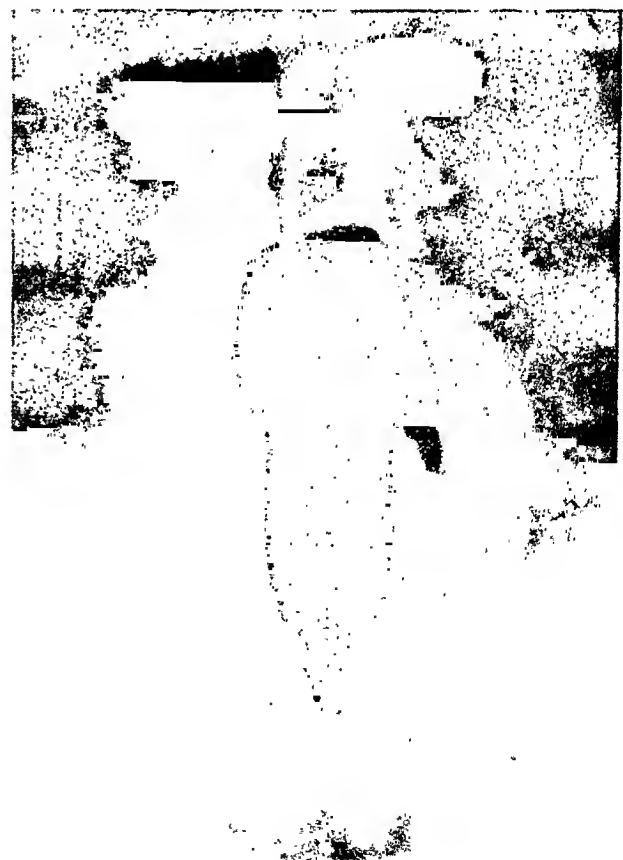


FIG. 31. Case N. P. "Amputation" of nerve root sheath by lateral protrusion of fifth lumbar disc on the right.



FIG. 32. Case M. L. Elevation of the left fourth lumbar nerve root sheath; lateral protrusion was found at operation.

inal operations in other institutions, sizable recurrences were demonstrated myelographically and found subsequently at operation (Fig. 37). In the third case a single large fourth lumbar protrusion was found and removed at this hospital; some weeks later myelography demonstrated a



FIG. 34. Case S. G. Double protrusions, fourth lumbar midline and fifth lumbar left.

large defect at the same level and a caudal sac terminating at the level of the fifth disc. Re-operation disclosed disc protrusions at both levels.

Postoperative myelographic studies have been made of only 4 other patients, all of whom were symptom free at the time of examination. All showed slight but definite distortions of the canal at the levels of former protrusions but less prominent deformities of the nerve root sheaths. While this



FIG. 33. Case F. T. Double protrusions, fourth lumbar right and fifth lumbar left.

FIG. 36. Case J. R. Elevation of right fourth and fifth lumbar nerve root sheaths; lateral protrusions were found.

series of postoperative studies is small, it is our impression that myelographic findings in this group are not significant unless the defects are large and well defined.



FIG. 35. Case R. S. "Amputation" of right fourth and fifth lumbar nerve root sheaths by lateral protrusions.

#### HERNIATIONS OF CERVICAL INTER- VERTEBRAL DISCS

Scant consideration has been given in past years to herniations of cervical intervertebral discs. Recent studies, however, indicate their relatively common incidence and their importance in explaining cases of heretofore obscure brachial neuralgia and neuritis. In former years such herniations

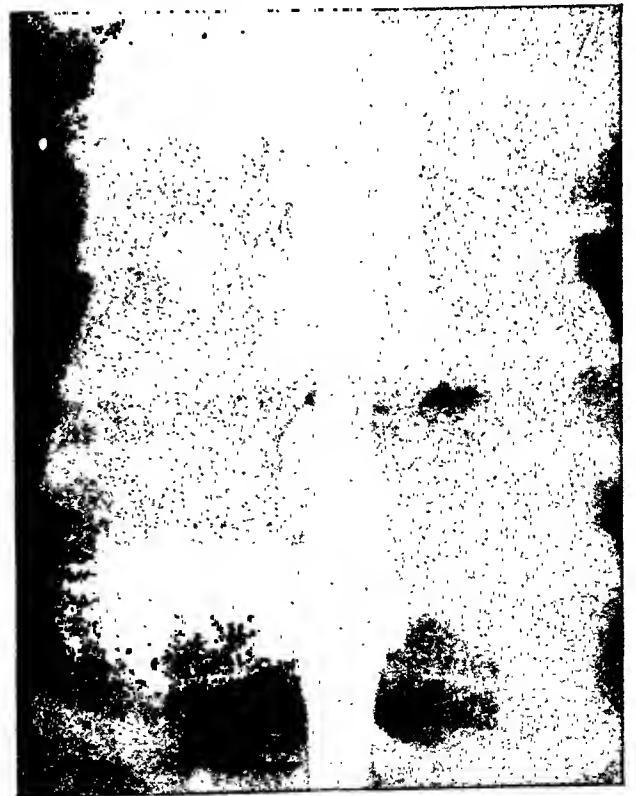


FIG. 37. Case G. S. Recurrent fourth lumbar herniation with distortion of the canal and nerve root sheaths.



FIG. 38. Case R. F. Narrowing of the fifth cervical interspace with osteophytes about the vertebral bodies. Myelogram of this case is shown in Figure 42.



FIG. 40. Cervical myelogram following injection of 6 cc. of pantopaque by the lumbar route, with filling of the lower five cervical nerve root sheaths. While a questionable slight deformity was present in the region of the left sixth cervical root sheath, clinical findings were not sufficiently conclusive to warrant exploration.



FIG. 39. Case M. F. Oblique projection demonstrates narrowing of the left intervertebral foramen

usually were not differentiated from spinal cord tumors, either clinically or pathologically. The lesions removed were considered to be extradural chondromas by Elsberg<sup>2</sup> and other observers.

In 1942, Senimes and Murphey,<sup>7,8</sup> described a syndrome characterized by pain in the neck radiating to the shoulder, precordium and arm, and by sensory changes in the index and middle fingers on the affected side. Bucy and Chenault<sup>1</sup> in 1944 reported a case of compression of the seventh cervical nerve root by herniation of an intervertebral disc.

In 1944 Spurling and Scoville<sup>19</sup> reported a group of patients with radicular pain in the upper extremity due to lateral rupture of the fifth or sixth cervical intervertebral

with osteophytes about its margins. Myelogram is shown in Figure 43.

FIG. 42. Case R. F. Lipiodol cervical myelogram. In spite of globulation of oil, a large lateral and mid-line defect is visualized above the sixth cervical vertebra on the left. A moderately large protrusion was found compressing the sixth cervical nerve root.

disc. They introduced the "neck compression" test. By tilting the head and neck toward the side of the lesion, the patient's radicular pain is reproduced. Pressure on top of the head increases the pain. This test has proved to be of much value in differentiating cases of brachial neuralgia due to lateral herniations of the cervical intervertebral discs from those due to other causes.

In more than 50 per cent of all cases of herniations of cervical discs, lateral and oblique roentgenograms of the cervical spine demonstrate localized narrowing of the affected disc (Fig. 38) and osteophytes about the margins of the vertebral bodies



FIG. 41. Case A. B. Questionable minimal defect involving the right sixth nerve root sheath above the body of the sixth cervical vertebra. This patient was not explored but clinical and roentgenological findings suggest a small lateral protrusion.



FIG. 43. Case M. F. Pantopaque myelogram demonstrating lateral defect involving the left sixth cervical nerve root sheath. A protrusion was found at operation.

and intervertebral foramina (Fig. 39). Pantopaque myelography provides an excellent method of confirming the diagnosis and of localizing accurately the site of the protrusion.



FIG. 44. Case B. O. Pantopaque myelogram demonstrating a defect above the seventh cervical vertebra on the right. At operation a moderately large herniation of the disc between the sixth and seventh cervical vertebrae was found with compression of the seventh cervical nerve root.

In the normal cervical myelogram, filling of the nerve root sheaths appears to be more satisfactory with pantopaque than with other contrast media. Small lateral herniations cause a failure of filling of the nerve root sheath on the side of the lesion. Large herniations produce defects in the opaque column as well as in the affected nerve root sheaths.

Four cases of herniation of cervical intervertebral discs were operated upon in this series (Fig. 14, 42, 43 and 44). As noted above, one patient was believed preoperatively to have an extramedullary tumor; the other 3 cases were diagnosed correctly. Figures 40 and 41 demonstrate minimal de-

fects of doubtful significance; both of these patients had clinical findings suggestive of herniations but were not explored.

Complete blocks are rare and none were found in this series. Such patients rarely have radicular pain or paresthesia alone and usually present symptoms of spinal cord compression. Figure 45 is a reproduction of a roentgenogram (not in our series) which demonstrates a complete block. This patient had a quadriplegia and was thought to have a cervical spinal cord tumor. Two cubic centimeters of iodized oil introduced into the cisterna magna were arrested opposite the fifth cervical intervertebral disc. At operation, a large disc herniation was found.



FIG. 45. Complete cervical block demonstrated by lipiodol introduced by cisternal puncture. Disc found at operation. (Case not in this series.)

#### DIFFERENTIATION FROM SPINAL CORD TUMORS

It is difficult and frequently impossible to differentiate a large disc herniation from a spinal cord tumor, especially the extramedullary type. While a tumor may be situated anywhere, almost all herniations

are noted opposite intervertebral discs, anterior or lateral to the subarachnoid space of the spinal canal; rare exceptions are noted when herniations become detached and lie free in the epidural space (Fig. 26). A tumor may erode vertebral bodies and pedicles; a herniation never does.

#### PANTOPAQUE AS A CONTRAST MEDIUM

In comparing pantopaque with other contrast media, it is our impression that there are certain definite advantages in the use of pantopaque over other available substances with few discovered disadvantages.

An ideal contrast medium should have the following characteristics: (1) it should be sufficiently radiopaque or radiolucent to offer moderately high contrast to surrounding tissues; (2) it should be non-irritating and non-toxic; (3) it should be absorbed completely without evidence of pharmacologic effect on any body tissues; or (4) if not absorbed, it should have physical characteristics which allow it to be removed completely and easily; (5) it should have the proper density and viscosity to allow it to flow readily in a homogeneous stream over the dependent portions of the subarachnoid space of the spinal canal and to fill the axillary pouches and sheaths of the spinal nerve roots; and (6) it should be of such a nature that it can be used to visualize all portions of the spinal canal.

To date, no contrast substance has been developed which meets all requirements of an ideal medium.

The use of air and oxygen for myelography obviates the objection to an irritating and non-absorbable medium. However, there are certain inherent disadvantages in their use. Considerable discomfort usually follows such injections; gas offers low contrast and minimal defects are not visualized in many cases. Gas is of no value in myelographic studies of the cervical and thoracic spine.

Thorotrast has had a very limited use in myelography. Thorium compounds are

irritant and radioactive and most workers have been reluctant to inject a medium of this kind into the subarachnoid space.

Absorbable iodide compounds such as diodrast have been employed experimentally for myelography but have produced sufficient local irritation as to render them unacceptable for clinical application.

Lipiodol, first introduced for intraspinal use by Sicard and Forestier<sup>9</sup> in 1922, and for demonstrations of herniations of intervertebral discs by Mixter and Barr<sup>5</sup> and Hampton and Robinson<sup>3</sup> in 1934, has been the medium used most frequently in the past. It is highly radiopaque and flows fairly readily although somewhat sluggishly. While in the average case it flows in a homogeneous stream, it has a tendency to break up into small globules, especially if the stream of oil loses continuity in the course of injection or manipulation. Once this occurs, it is usually impossible to restore homogeneity to the pool. This property makes it especially unsuitable for cervical myelography.

Lipidol is absorbed very slowly, if at all, and if incompletely removed may lodge indefinitely in the ventricles, cisterns or subarachnoid space of the brain or in the spinal canal or along the spinal nerve root sheaths. While all or nearly all of the oil can be removed in most cases, it is sufficiently viscous so that injection and removal are frequently difficult.

There is some uncertainty regarding the toxic or irritating qualities of lipiodol. Mild immediate reactions have been observed in occasional cases and a few observers claim that retained lipiodol exhibits slightly irritant characteristics. Considering the fact that lipiodol had been used as a myelographic medium for years before a satisfactory technique was developed for removal, the number of cases reported in which there was alleged irritation by the retained oil have been very few indeed. Certainly it cannot have very marked irritant qualities or more conclusive evidence to that effect would have been produced by this time.



In general, however, lipiodol has proved to be a very valuable agent for myelography in spite of the disadvantages described above.

Pantopaque, a mixture of ethyl esters of isomeric iodophenylundecylic acids, is an oil type of fluid, colorless to pale yellow in appearance, with a specific gravity of 1.263 at 20° C. It contains 30.5 per cent of iodine in organic combination as compared with 40 per cent of iodine in lipiodol, and at 37.5° C. is one-seventeenth as viscous as lipiodol. Being of low viscosity it is injected and withdrawn with ease. There is less likelihood of pantopaque entering the epidural space as no force is required to inject it.

It moves up and down the canal more rapidly than lipiodol. Frequently, it breaks up into droplets; when re-pooled, it tends to flow together again more completely than lipiodol.

It appears to flow more readily into nerve root sheaths than lipiodol, thus outlining small defects more effectively.

While pantopaque in the subarachnoid space of animals exhibits moderate toxicity, no irritant or toxic manifestations have been observed in man in cases where the medium has been left in the spinal canal.

Ramsey, French and Strain<sup>6</sup> report that, if left in the subarachnoid space, pantopaque is absorbed at the rate of approximately 1 cc. per year. Wyatt and Spurling<sup>12</sup> studied 6 patients in whom 3.5 cc. of pantopaque was injected into the lumbar subarachnoid space and left in place. Subsequent roentgenographic studies were made of the skull and entire spine and estimates made as to the amount of residual pantopaque present. Quantities varying from about 2.1 to about 1.5 cc. were found to remain at intervals ranging from nine to fifteen months after injection. None of the patients had symptoms referable to the retained pantopaque.

In 41 per cent of our cases all of the pantopaque was removed at the conclusion of the myelographic examinations; in an ad-

ditional 45 per cent of cases 95 per cent or more was removed; in 12 per cent, 30 to 95 per cent was removed; in 2 cases (less than 2 per cent), none of the pantopaque was removed. No ill effects were noted in any patient from whom the pantopaque was not completely removed.

#### RÔLE OF MYELOGRAPHY IN THE DIAGNOSIS OF HERNIATIONS OF INTERVERTEBRAL DISCS

The diagnosis of herniation of one or more intervertebral discs should be based primarily upon the clinical features of the case. A complete history and neurological examination will suggest the correct diagnosis in most cases. However, it is frequently impossible from clinical findings alone to localize precisely the protrusion or to rule out multiple protrusions.

A careful and complete roentgen examination of the spine should precede myelography, not merely to rule out anomalies and abnormalities but to give the examiner a picture, or map as it were, of the area which he is to study subsequently with contrast material. In the lumbar spine, abnormalities such as narrowing of an interspace, presence of osteophytes about the vertebral bodies adjacent to a herniated disc, or alterations in width of an interspace on anteroposterior and lateral flexion and extension are noted in a minority of cases. In the cervical spine, localized narrowing of an interspace with osteophytes about the margins of the vertebral bodies and intervertebral foramina are seen more frequently with a disc protrusion.

Pantopaque myelography should precede exploration in nearly every case for the following reasons:

(1) It offers objective evidence as to the presence of a lesion. It should be noted, however, that negative findings do not exclude the presence of herniations lateral to the limits of the subarachnoid space, which are found in a small minority of cases.

(2) It localizes the lesion and provides valuable information regarding the presence or absence of multiple herniations.

(3) The procedure is a simple, safe and nearly painless one.

(4) If pantopaque is left in the subarachnoid or epidural space, there is evidence that the retained substance is non-irritant, non-toxic and is absorbed slowly.

(5) While the operation for removal of a herniated disc is not formidable, it is sufficiently serious so that all information possible should be available before it is undertaken.

Myelography is of least value in patients with narrow spinal canals or with underdeveloped nerve root sheaths, especially if the herniation is small and laterally placed. Apparently high terminations of the caudal sac at or above the fifth lumbar disc level should be viewed with suspicion in patients with clinical evidence of herniation of a low lumbar disc.

#### COMMENT

Conflicting opinions by eminent neurosurgeons, roentgenologists, and orthopedists regarding the value of myelography in the diagnosis of protrusions of the intervertebral discs have resulted in confusion and bewilderment among the general medical public in the treatment of such cases. The introduction of an easily removable, non-toxic contrast medium has obviated most of the objections to contrast myelography. The injection and removal of pantopaque are only slightly more difficult than performance of a lumbar puncture. No untoward sequelae or complications referable to myelography with pantopaque have been noted.

Myelography should be done in nearly every case of low back pain with sciatic radiation before the patient is subjected to a fusion operation on the spine or sacroiliac joints. Thus many unnecessary and fruitless operations will be avoided. The removal of a herniated intervertebral disc from the lumbar or cervical region can be

accomplished through a small incision and with minimal disturbance to the bony structures. Myelography provides sufficiently accurate localization so that the operative procedure may be limited to the site or sites of the lesions.

Pantopaque myelography occupies much the same place in the study of spinal lesions that pneumo-encephalography occupies in the study of cerebral disorders. Neither method replaces careful clinical study; both, however, are valuable adjuncts to neurologic diagnosis.

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## ARTERIOGRAPHY FOR THE DEMONSTRATION OF INTRACRANIAL ANEURYSMS

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ALTHOUGH it is one hundred and seventy-five years since arterial aneurysms of the brain were first recognized at autopsy, relatively few cases are even now being diagnosed during life. Of these the majority are still disclosed during operation for other intracranial lesions; e.g., of aneurysms found on the basilar and vertebral arteries in reported cases by Dandy, 11 of 21 were disclosed during operations for trigeminal neuralgia and Ménière's syndrome.

In 1927, Egas Moniz<sup>7</sup> introduced arterial encephalography and in 1933 he reported the first demonstration of an intracranial aneurysm of the right internal carotid artery by means of cerebral arteriography, thus giving new impetus to the search. Since then, many cases have been diagnosed by this method. Although the injection of the internal carotid has usually been done directly following dissection of the vessel, other techniques have also been recommended. Direct puncture of the common carotid artery to obtain intracranial arteriograms was reported by Loman and Myerson<sup>15</sup> in 1936. Although direct puncture is not a formidable procedure, it requires much skill. The introduction of contrast material into the basilar artery can only be accomplished by the open operative techniques and this latter procedure has been adequately described in the paper by King.<sup>12</sup> It is our belief that the injection of the common carotid will not satisfactorily demonstrate the cerebral arteries since blood and the contrast medium will be shunted through vessels which do not directly supply the cerebral hemispheres. For this reason, dissection of the internal carotid on the side of the suspected lesion with introduction of the contrast material under direct visualization is advocated.

Although thorotrast has been generally used as the radiopaque medium for angiography, a state of doubt concerning its safety still exists. Because of the possibility that the injection of radiopaque thorium dioxide solution may cause toxic symptoms later, the use of thorotrast has been discontinued by many investigators. Others are not impressed by this possibility as a serious objection.<sup>25</sup> However, Northfield and Russell<sup>18</sup> have described histologic studies in 4 cases in which thorotrast was retained in the lumen of the walls of the cerebral vessels following angiography. Actual occlusion of vessels by thorotrast was suspected in one case and this must be considered a very serious criticism of this opaque medium. A similar criticism is also applicable to the use of umbrathor. In 1938, Ekström and Lindren<sup>9</sup> published reports which demonstrated cerebral thromboses in 60 per cent of the brains which came to necropsy after intracarotid injection of thorotrast. No reports of such untoward sequelae following the use of diodrast have been reported. More recently diodrast, neoskiodan, uroselectan and similar preparations made for excretory urography have been utilized in cranial arteriography. These substances are non-toxic in the doses used, are quickly excreted from the body and do not damage the intima of the vessel. The density of the shadow of diodrast and similar iodine containing compounds, when utilized for arteriography, while satisfactory is not as marked as that produced by colloidal thorium dioxide. While none of the untoward effects and potential dangers ascribed by Gross<sup>10</sup> to the use of thorotrast have occurred in our group of cases, the 50 per cent solution of diodrast compound is now being used. Because of the reactions described by Gross

following the use of a solution of 70 per cent diodrast, this concentration has not been used. The use of the 35 per cent diodrast did not produce satisfactory visualization of the cerebral circulation. Thorotrast has been used in the injection of 13 of our cases, while 50 per cent diodrast compound has been used in 2 additional cases. Numerous procedures have been devised for the obtaining of complete cerebral angiograms. Thus Egas Moniz devised a serigraph termed the "escamateador" which permitted the rapid exposure and removal of cassettes. In this manner the serial visualization of the arteries and veins of the cerebral hemispheres could be made. Sanchez-Perez has more recently devised a portable apparatus which could be adapted to any roentgenographic table. Most of the investigators utilizing cerebral angiography have contented themselves with the making of single or double exposures. The techniques of the special devices suggested by Egas Moniz<sup>2</sup> and Sanchez-Perez<sup>29</sup> require special devices and these may not be available. In our cases, the surgeon has requested that the procedure be completed in the operating room and, for this reason, a simplified technique utilizing a portable roentgen apparatus was devised. Complete and satisfactory angiograms can be made by this method under sterile operating techniques. In addition, should further operative procedure be necessary, these may be completed after the viewing of the angiograms.

With the exception of the isolated reports such as those by Schüller,<sup>3</sup> Lodge, Walker and Stewart,<sup>4</sup> Zollinger and Cutler<sup>5</sup> and the very comprehensive reports by Sosman and Vogt<sup>12</sup> and Albright,<sup>6</sup> arterial aneurysms of the circle of Willis have received scant mention as problems in roentgen diagnosis. Pincherle,<sup>7</sup> in addition to crediting Schüller with the roentgenographic demonstration of an aneurysm of the internal carotid artery, stated that the reports by Schüller and by Speis and Pfister<sup>8</sup> were the only ones recorded in the literature up to the year 1922. In addition

to the characteristic changes shown by the curved linear calcifications demonstrated in the supra- and parasellar area found in the walls of aneurysms, destructive changes should also be sought for in the margins of the sphenoidal fissures and in the carotid. However, there is nothing distinctive about the sellar destruction and sphenoidal fissure erosion. Such changes can be caused by tumors as well as aneurysms. Since the first visualization of an intracranial aneurysm by Egas Moniz, the graphic demonstration of other aneurysms by arteriography has been noted by other observers. In addition to demonstration of the internal carotid vessels, more recently the vertebral artery has also been injected by Takahashi<sup>21</sup> in 1940 and by King<sup>22</sup> in 1941. No angiographic demonstration of aneurysms in this vessel and its components has as yet been recorded. Injection of the vertebral artery produces better demonstration of the posterior communicating and posterior cerebral arteries. The use of arteriography to examine the basilar and vertebral arteries to exclude aneurysms is of special value for the following reasons: As yet the characteristic curvilinear calcifications found in the sellar region emphasized by Sosman and Vogt and by Dyke<sup>9</sup> have not been demonstrated in instances of the basilar or vertebral aneurysms because of the obscuring shadows of the petrous ridges and mastoid bones. Both Dyke and Dandy have suggested that encephalography could demonstrate aneurysms as definite intracranial lesions of uncertain identity.

Dandy<sup>1</sup> states in his excellent monograph that while important information is unquestionably obtained from angiography, it has also assumed an ever increasing though greatly overdone rôle in vascular lesions of the brain. However, when it is considered that in the group of aneurysms found in the basilar and vertebral arteries, 11 of the 21 cases were discovered during operative procedure for trigeminal neuralgia and Ménière's disease, the need for more accurate preoperative diagnosis becomes apparent. Similarly, aneurysms in

the carotid vessels have also been disclosed during operation for trigeminal neuralgia by Magnus<sup>16</sup> and Jefferson.<sup>11</sup> Zollinger and Cutler, Lodge *et al.*, and Albright noted instances where because of the symptomatology as well as the sellar deformity, the presence of an aneurysm has led to the preoperative roentgenological diagnosis of hypophyseal tumor, suprasellar tumor or cyst.

The entire procedure is carried out in the operating room so that there is no transporting of the patient and so that a completely sterile technique is adhered to throughout. A mobile apparatus is used and positioned so that lateral roentgenograms can be made since this view has proved to be of greatest value in the recognition of aneurysms. The factors used are as follows: The tube target distance is 35 inches, 80 kilovolts, 25 milliamperes, one-quarter second exposure. A Lysholm or Bucky-Potter diaphragm was not employed. A trial roentgenogram is made prior to the introduction of the contrast medium with the patient supine to determine if the position is correct and if the roentgen technique is satisfactory. This film is immediately processed so that whatever corrections are necessary are immediately undertaken. We have noted that film exposures made with a high speed technique employing a rotating anode tube have not proved as satisfactory as those made at slower speeds employing one-half or one-quarter second.

The technique employed for the visualization of the intracranial circulation by means of the injection of contrast medium into the internal carotid and the vertebral arteries is as follows: The dissection and visualization of the carotid sheath are carried out in the operating room by the supervising neurosurgeon. In the cases where injection of the vertebral artery is desired, the dissection is continued until the anterior scalenus muscle is seen. The sixth cervical vertebra is then found and the vertebral artery is freed from the surrounding tissues and followed to its origin from the subclavian artery. A broad catgut ligature

is then passed under the artery in order to produce fixation and to temporarily occlude the vessel during the introduction and injection of the contrast medium. The adequacy of the collateral circulation by use of the Matas test, i.e., compression of the internal carotid artery in the neck, can be done upon the exposed vessel. A straight No. 18 gauge needle is introduced into the internal carotid, care being exercised to avoid puncture of the opposite wall. It is well to note the very excellent suggestion offered by King to inject the vertebral artery in which a No. 18 gauge lumbar puncture needle bent at right angles is used to introduce contrast material. In this manner the needle can be introduced along the same axis as the vessel well up into the vessel and yet the danger of puncturing the opposite wall is avoided. Following the preparation of the mobile roentgen apparatus, the needle is attached to a syringe containing 10 cc. of colloidal (thorium dioxide) thorotrast or 15 cc. of 50 per cent diodrast and is introduced into the vessel to be injected. At the beginning of the injection, the vessel is occluded below the inferior point of insertion of the needle by the previously placed ligatures. At a given signal, the contrast material is injected as rapidly as possible. When approximately three-quarters of the solution has been introduced, the first exposure is secured. A technician properly protected by lead gloves and apron and lead protective screen then makes rapid changes of the cassettes and three films are exposed at three second intervals. A final exposure is made at the end of twelve seconds. Careful coordination and a previous practice round have proved invaluable in this type of examination in order to secure adequate and complete angiograms. This procedure has been selected as the most favorable one after previous and other various techniques were employed. Previously, in several angiograms, a single lateral film only was made at the completion of the injection. Such a procedure is not adequate and it is possible that actual failure to demonstrate the aneurysm may



FIG. 1. Plain roentgenogram of the skull. This is made to determine if the position is correct and the roentgen technique satisfactory.

result. A case is described by Krayenbühl<sup>12</sup> in which an arteriogram was made and aneurysm was not disclosed but it was later demonstrated by operation.

A group of 15 arteriograms have been completed. One arteriogram was made in a case of suspected glioma and is excluded from this series. An attempt was also made to inject the internal carotid artery post-mortem in a case where rupture of an aneurysm was suspected but permission for pathological examination of the brain could not be obtained. This group of cases with the roentgen aspects in a group of aneurysms as demonstrated by arteriography and the subsequent course following the injection of thorotrast will be discussed in a future paper.

In order to demonstrate the difficulties concerned in the diagnosis of an intracranial aneurysm, the case history of one of our series is given. It will be seen that although localizing disturbances were present and an aneurysm was suspected, it was necessary to consider other lesions.

#### REPORT OF CASE

M. C., female Italian, factory worker, aged thirty, was admitted to Grace Hospital on November 23, 1943. She was disoriented and complained of marked dizziness and left-sided headaches. It was learned that one month prior

to admission, she had complained of headaches that were extremely severe in the morning. Eleven days before admission while at work, she complained of a sudden severe pain in the head which was localized to the left frontal area and above the left ear. Brought to the rest-room, she stated that she heard noises within her head. She appeared dazed and her eyes were deviated to the right. Her speech was unintelligible and she could not move her legs. Approximately fifteen minutes later, she had marked projectile vomiting. The next day, the symptoms persisted and she vomited several times. Nine days before admission, she improved slightly. She was able to stand and her speech was intelligible at intervals. Seven days before admission, she became markedly confused and complained of severe left-sided headaches.

In the previous medical history, the patient stated that she had had a chronic left otitis media for the past five years.

The physical examination demonstrated a completely disoriented female because of the motor and sensory aphasia and paraphasia. The pupils were round, regular, equal and reacted normally to light. Diplopia was present. The patient closed one eye for near vision. There was no evidence of nystagmus or exophthalmos.

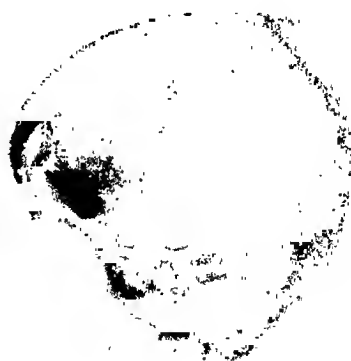


FIG. 2. The contrast medium has been injected into the internal carotid and is seen outlining the carotid siphon. The aneurysm arises from the internal carotid artery near its junction with the middle cerebral artery. This is the type of aneurysm which is classified as the supraclinoidal type by Egas Moniz. Contrast medium in the original roentgenograms could be seen outlining the ophthalmic and anterior choroidal arteries. Three-quarters of the total amount of the contrast material has been injected.



The fundi showed some papilledema and the veins appeared distended.

A neurologic examination attempted on admission of the patient was not satisfactory and an additional complete examination was done a day later when the patient was more cooperative. In the examination of the eyes, there was no evidence of paralysis of the fourth and sixth nerves. The patient showed diplopia with marked ptosis of the left lid. There was anesthesia of the first and second branches of the right trigeminal nerve. The acuity of the eighth nerve on the left was diminished. There were



FIG. 3. The contrast medium is seen outlining portions of the arterial system. Small amounts are also noted in the venous tributaries. The exposure is made three seconds after the first exposure.

involuntary movements of the left arm and the right showed less motor power than that on the left. In addition, there was increased tonus of the right arm. Superficial abdominal reflexes were absent on the right and a Babinski could also be elicited on the right. The blood pressure was 110 systolic, 76 diastolic. Negative Wassermann and Kolmer tests were reported. Examination of the spinal fluid showed a slight xanthochromia. The red cell count of the spinal fluid was 10,900, 190 monocytes were seen and there were 2 polymorphonuclear leukocytes. The total protein was 27 mg. per 100 cc. The lumbar spinal puncture revealed initial pressure of 340 mm. H<sub>2</sub>O; 6 cc. of pink cerebrospinal fluid was removed for examination.

Because of a low grade fever, the presence of a brain abscess could not be excluded at this time and it was deemed advisable to rule out a brain tumor. Sulfadiazine was administered

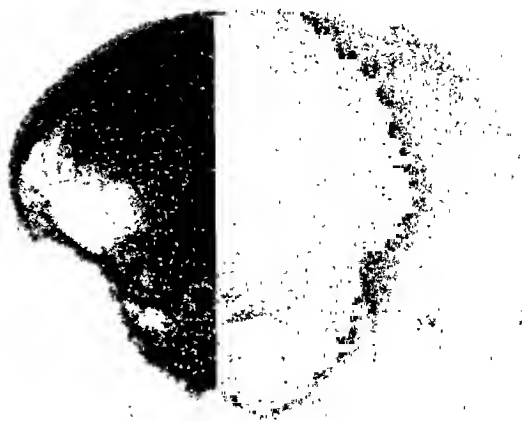


FIG. 4. Large venous channels are outlined by the contrast medium. The aneurysm is still filled. This exposure is made six seconds after the first exposure.

to the patient. For sixteen days, the patient improved slowly. On the nineteenth hospital day, a complete Weber's syndrome was noted. The patient complained bitterly of a pounding left frontal headache. The temperature at this time was normal and sulfadiazine therapy was discontinued.

A neurosurgical consultant at this time suggested that an aneurysm or a tumor with hemorrhage could produce the syndrome. Ventriculography, however, revealed no evidence of displacement or deformity of the ventricles and no definite tumor mass could be demonstrated.



FIG. 5. Only a trace of contrast medium can be visualized in the venous system. It is still retained in the aneurysmal dilatation. Final exposure is made twenty-two seconds after the first exposure.

Some decalcification of the lesser sphenoidal wing, was noted on the previous roentgen examination and the roentgenologist suggested that an attempt be made to exclude a vascular lesion in this area.

On the fifty-first hospital day, angiography was done, the neurosurgeon supervising the operative procedure. The collateral circulation was demonstrated to be adequate by the Maras test. The internal carotid artery was then injected under direct visualization using 10 cc. thorotrast (Fig. 1, 2, 3 and 4). A roentgenogram was made at the end of approximately twenty-two seconds in which contrast material could be seen remaining in the aneurysm (Fig. 5). The internal carotid was then ligated but not divided. There was marked improvement of the physical signs following the ligation and no complications ensued. The patient was discharged and has been followed for approximately two and one-half years. At the present time, the patient is entirely well.

Since the time of operation, she has been free of all of the symptoms. The papilledema and congestion of the retinal veins are no longer demonstrable. The patient is able to elevate the left upper lid so that the entire pupil can be exposed.

It is to be stressed that in this case the patient had refused to undergo any cranial operative procedure so that it was impossible to attempt clipping of the internal carotid intracranially as recommended by Dandy. The sudden severe pain complained of by the patient was apparently due to vascular expansion and possible rupture of the aneurysm. Roentgen examinations demonstrated no evidence of erosion of the clinoid processes although some decalcification of the lesser sphenoidal wings had been indicated. Ventriculography in this case demonstrated no defects in the region of the cisterna interpeduncularis and chiasmatis. Although the signs and symptoms became more marked as the patient remained in the hospital, apparently a diagnosis could not be satisfactorily arrived at when the patient was first admitted.

Adequate angiography will demonstrate the contrast material entering into the skull. In 70 per cent of cases, the carotid artery describes a complete "S" curve and

then divides into the anterior and middle cerebral vessels. The term "carotid siphon" has been coined to designate the bends of the carotid artery before its branching. The middle cerebral artery in the majority of cases then divides almost immediately into the posterior temporal, the posterior parietal and the angular gyrus. The anterior cerebral vessel passes forward and upward and has one important branch, the pericallosal which follows the outline of the corpus callosum. In several cases, the origin of the ophthalmic and the anterior choroidal vessels from the internal carotid with the ramifications in the orbit has also been noted. The later roentgenograms demonstrate the contrast material leaving the skull via the veins. It is interesting to note in our illustrations the manner in which the aneurysm is still outlined by the contrast medium although the major portion of the medium has left the intracranial vessels. In our cases, reference to the illustrations in the text by Egas Moniz has proved invaluable in the interpretation of angiograms.

We wish to thank Dr. B. S. Brody for his aid and suggestions in the preparation of this case. In addition, we wish to thank Mr. Harold E. B. Shea, R.T., Head Technician of the Grace Hospital for his technical assistance.

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# THE DISEASES OF THE VERTEBRAL COLUMN

## A ROENTGENOLOGIC ANALYSIS\*

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### I. OBJECT OF THE STUDY

**A**NATOMICAL lesions of the spine have a high incidence but produce clinical manifestations in only a minority of cases. For instance, in a series of 1,824 vertebral lesions of all kinds, in which the correlations between clinical and roentgen findings have been analyzed during the past nine years, there were clinical signs and symptoms referable to the vertebral lesion in only 28 per cent of the patients. Common clinical manifestations of disease of the spine—viz., pain in the back and neck, limitation of vertebral movements, and evidence of nerve root involvement—may be caused by many different diseases other than vertebral, even in the presence of a vertebral abnormality, and the roentgenologic demonstration of a vertebral lesion does not prove the vertebral origin of the complaint. The question, then, is: Which are the lesions of the spine that do produce clinical manifestations, and why?

To answer this question, it is necessary to analyze the clinical findings, to analyze the roentgen findings, and to examine whether correlations can be established between them. The first step consists in defining the vertebral lesions as accurately as possible. The historical definitions, based upon entirely different principles, cannot be used for this purpose. Some order has to be found into which the phenomena can be grouped in accordance with the canons of classification.

If, for the purpose of this study, one regards the diseases of the spine as nothing but vertebral localizations of the diseases of bone and joints, the vertebral lesions would seem to fall naturally into four main groups:

1. Diseases of vertebral bone (spondyl-osteitis\*)
2. Diseases of vertebral symphyses
3. Diseases of vertebral synovial joints (spondyl-arthritis\*)
4. Diseases of vertebral ligaments

Since the characters of bone and joint disease vary to some extent with the localization, it is to be expected that these diseases will show some particular features when they involve the spine. It is the object of this paper to define the roentgenologic appearances of the four groups of vertebral diseases.

### 2. DISEASES OF VERTEBRAL BONE

The lesions of vertebral bone may be grouped according to certain dominant morphologic characters:

1. Diseases of vertebral bone
  - a. Necrosing
  - b. Predominantly rarefying
  - c. Predominantly condensing and/or hypertrophic
  - d. Lesions of growing bone
  - e. Tumors

*a. Necrosing Bone Lesions.* Necrosis of vertebral bone is produced by the same causes as in other bones. Tuberculous and pyogenic infections are common causes; syphilis, brucellosis, mycoses, trauma, and roentgen irradiation may also induce necrosis. As in other bones, abscess formation may or may not develop, according to the variable factors involved.

As a rule, the vertebral bodies are involved much more frequently than the

\* In current usage, "osteitis" means bone disease, and "arthritis," joint disease. The terms do not necessarily imply inflammation. Although obsolescent and equivocal, these designations are still there for the sake of conformity with the literature, not generally at fault in the pathology of bone and joints, but more so in the general trend of this study.

\* *Journal of the American Roentgenology Society*, Boston, Mass., December 17, 1943.

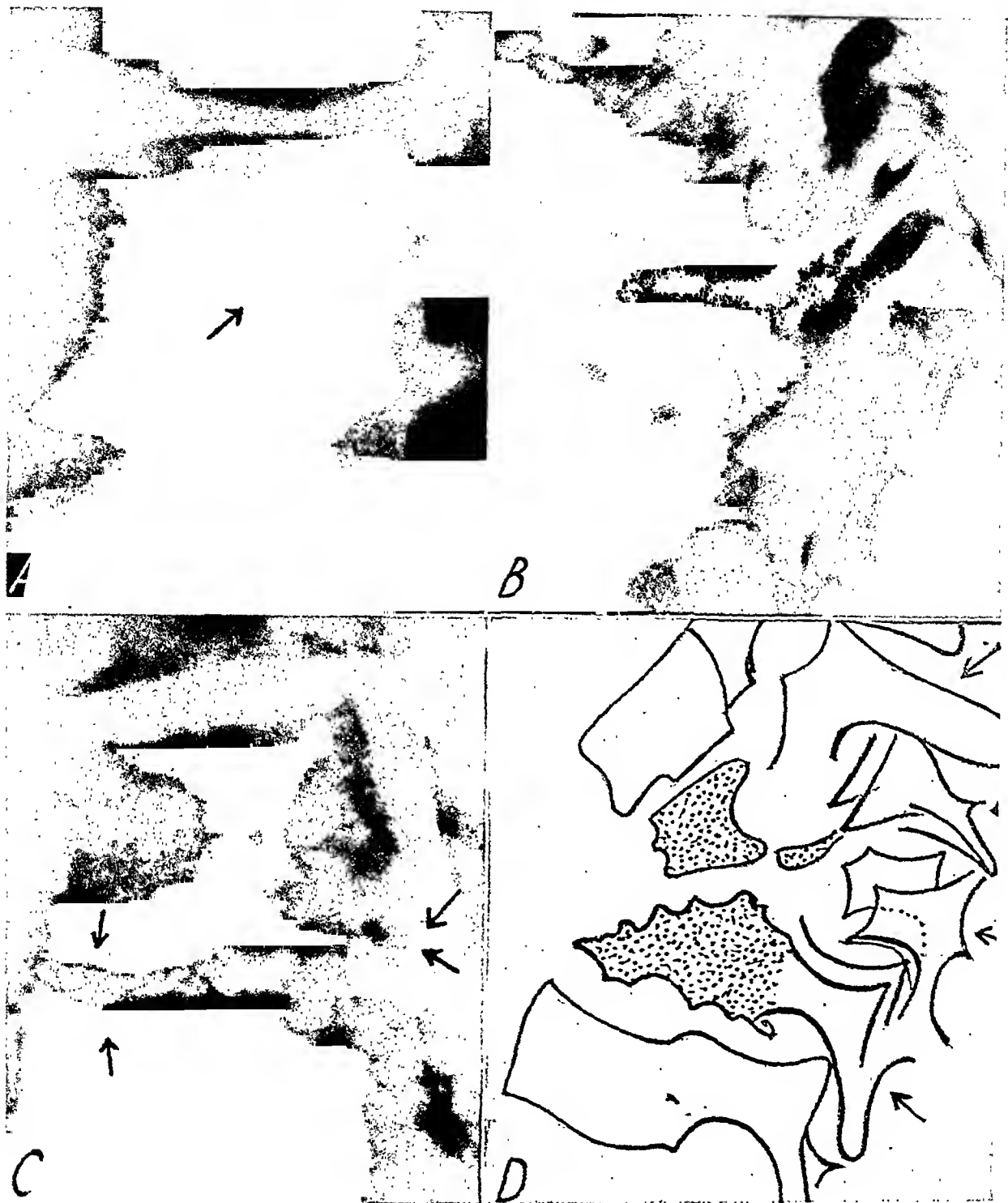


FIG. 1. Necrosing bone lesions. *A*, tuberculous necrosis confined to center of one vertebral body; duration, six years. No involvement of disc. *B*, roentgenogram, and *D*, tracing of case of tuberculous necrosis of vertebral bodies; the corresponding neural arches are nearly intact. *C*, tuberculous necrosis confined to marginal parts of contiguous vertebral bodies, with erosion of horizontal surfaces (white arrows), narrowing of disc space, and involvement of neural arch (black arrows).

neural arches. Apparently, the more abundant blood supply of the bodies favors invasion by blood-borne microbes, and the large venous sinuses in the bodies favor

bacterial growth;<sup>24</sup> moreover, the cancellous vertebral bodies, once involved, are more easily destroyed than the compact neural arches. For instance, when tuberculous

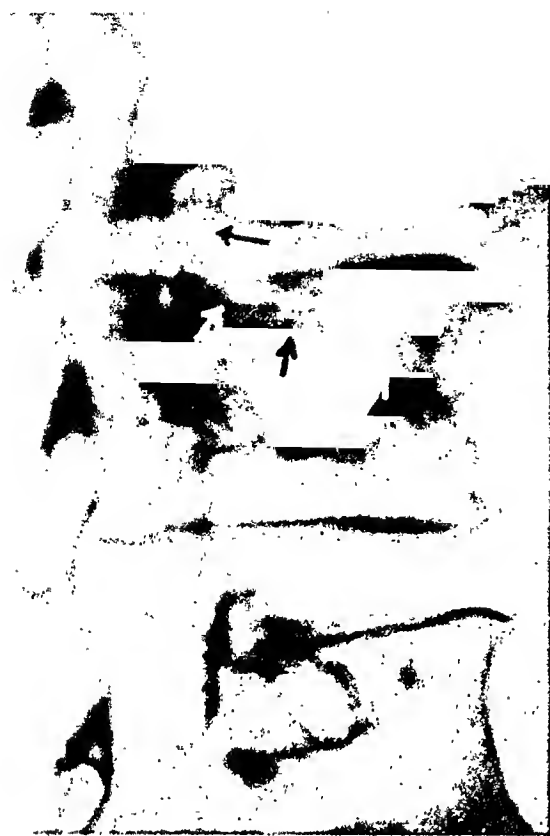


FIG. 2. Areas of recent destruction (white arrows) in a vertebral body showing condensation and osteophytes, the result of previous repair. Involvement of articular processes (black arrow).

necrosis takes a rapid course, the vertebral bodies become destroyed within a short time, but the neural arches remain intact and seem to point, as it were, to the empty spaces originally occupied by the bodies and discs (Fig. 1B). Necrosis may remain confined to the central part of a vertebral body (Fig. 1A), or to the marginal parts of contiguous vertebral bodies (Fig. 1C). The variable involvement of the vertebral discs in these cases will be discussed under heading 3 presently.

Low grade tuberculous and pyogenic infections may spread from the vertebral body into the neural arch<sup>13,14</sup> and erode it (Fig. 1C and 2); but necrosis beginning in, and confined to, the neural arch is rare. When present, it is usually caused by pyogenic infection,<sup>15</sup> but only exceptionally by tuberculous.<sup>16</sup>

The necrosed bone may become replaced

by new bone arising from adjacent areas. This repair is delayed and may even fail to occur when the infection is protracted, perhaps because the osseous connective tissue becomes fibrous. When infection is recurrent, new areas of necrosis may appear in regions showing signs of previous repair (Fig. 2). As a rule, bone repair is less definite in the neural arch than in the vertebral body. For instance, callus formation is usually absent or scanty in fractured neural arches and their processes. Only in the presence of low grade chronic disease does the neural arch form new bone, e.g., in Paget's disease. In this respect, the neural arch resembles the bones of the calvarium, to which it is related embryologically.

*b. Predominantly Rarefying Bone Lesions.* The vertebral bone may take part in systemic rarefaction, or demineralization, of the whole skeleton; or it may be involved by localized, or regional, rarefaction. Rarefaction is a reaction of bone to a large variety of etiologic stimuli and is not characteristic of any particular disease or group of diseases.

Since the cancellous vertebral body contains percentually less minerals than the compact neural arch, the bodies become rarefied more readily and rapidly than the arches. Indeed, systemic rarefaction of the whole skeleton often becomes evident in the vertebral bodies first.

Owing to the particular structure of the spine, certain secondary changes occur and are common to all types of vertebral rarefaction. Rarefied bone yields to pressure. The central perforated part of the horizontal surface of the vertebral body (lamina cribrosa) is structurally the weakest part of the vertebra and sustains the greatest statical stress.<sup>21</sup> Consequently this part rarefies especially easily and usually yields first. The adjacent disc, or a part of it, may then protrude into the vertebral body at this site;<sup>22,23</sup> this is known as intraspongious, or intravertebral, herniation of the disc, and as Schmorl's nodule (Fig. 3C). When rarefaction progresses, or is more severe, the entire horizontal surface may

yield to the pressure exerted by the expansible disc; this results in a semi-globular depression of the horizontal vertebral surface giving the appearance known as "fish vertebrae" (Fig. 3). Since, as a rule, the arches do not become rarefied as

traceable infection,<sup>7</sup> may cause a vertebral body to become severely rarefied and to collapse. Histopathologic findings<sup>8</sup> suggest that this is usually associated with pronounced hyperemia of the involved bone. Possibly the lesions known as Kummell's

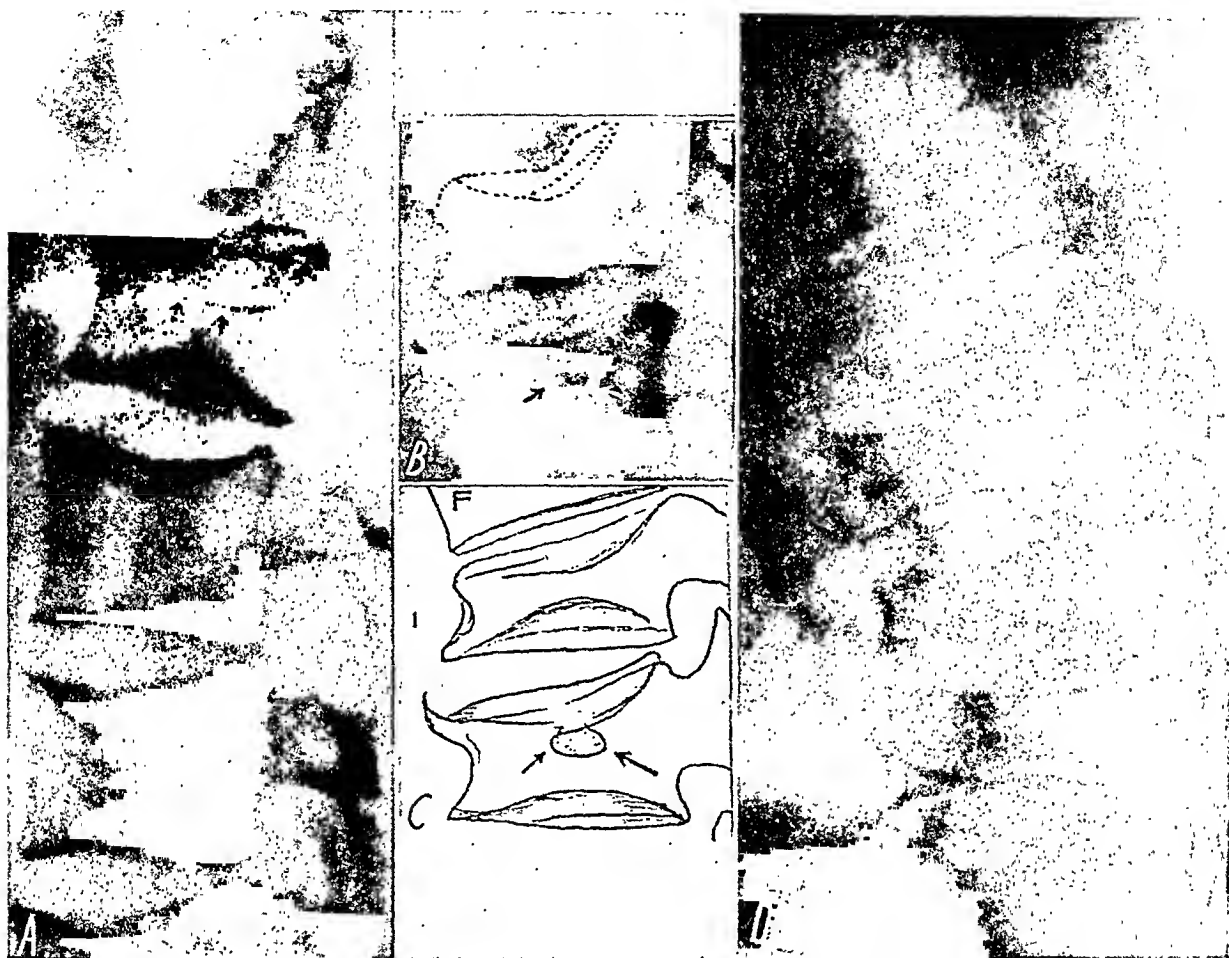


FIG. 3. Rarefaction. *A*, the lower vertebrae are held apart by the expanded discs, but the upper rarefied vertebrae have engulfed the expanded discs (black arrows), thereby producing narrowing of the intervertebral spaces and contact between vertebrae in spite of normal discs. *B*, roentgenogram, and *C*, tracing of a case with intravertebral herniation of disc (arrows) combined with expansion of the whole disc into the rarefied bone. *D*, compression of vertebrae and expansion of discs in a case of rarefaction of endocrine origin.

rapidly and severely as the vertebral bodies, they remain nearly intact while the bodies undergo compression. This leads to kyphosis in the thoracic spine, often associated with compensatory lordosis of the cervical and lumbar regions.<sup>7,21,23</sup>

In general, the degree of rarefaction corresponds roughly to the severity of the morbid stimulus; but sometimes rarefaction is out of proportion to the stimulus. In these cases an unnoticed trauma, or an un-

disease, Calve's vertebra plana, and certain types of adolescent kyphosis are merely different forms of the same basic disorder.

*c. Predominantly Condensing and/or Hypertrophic Bone Lesions.* Condensation and overgrowth of bone are both the result of production of new bone. New bone is coarser and denser than the original bone, as exemplified by bony callus. New bone formed within a bone is usually designated as condensation; and new bone formed



about the margins of a bone, as bone hypertrophy, exostosis, or osteophyte. Fundamentally, condensation and/or hypertrophy are secondary reactions, preceded in most cases by rarefaction or necrosis; but they may be dominant features, and the preceding rarefying phase may escape observation. According to the amount of condensation, the involved areas appear either coarse (as in Paget's disease) or very dense (as in marble bone disease). Condensation may be systemic (fluorine poisoning, certain tumor metastases), or localized and

caused by infectious, neoplastic, and traumatic lesions.

Systemic condensation involves the vertebral bodies and neural arches equally and simultaneously in most instances,<sup>11</sup> and seems to be the one disease in which the arches are as severely affected as the bodies. Tumor metastases often cause condensation in the vertebrae, but rarefaction and destruction in peripheral bones. Since condensation is usually a consequence of rarefaction—*un témoin de la raréfaction*, as Leriche and Policard put it—it is conceiv-

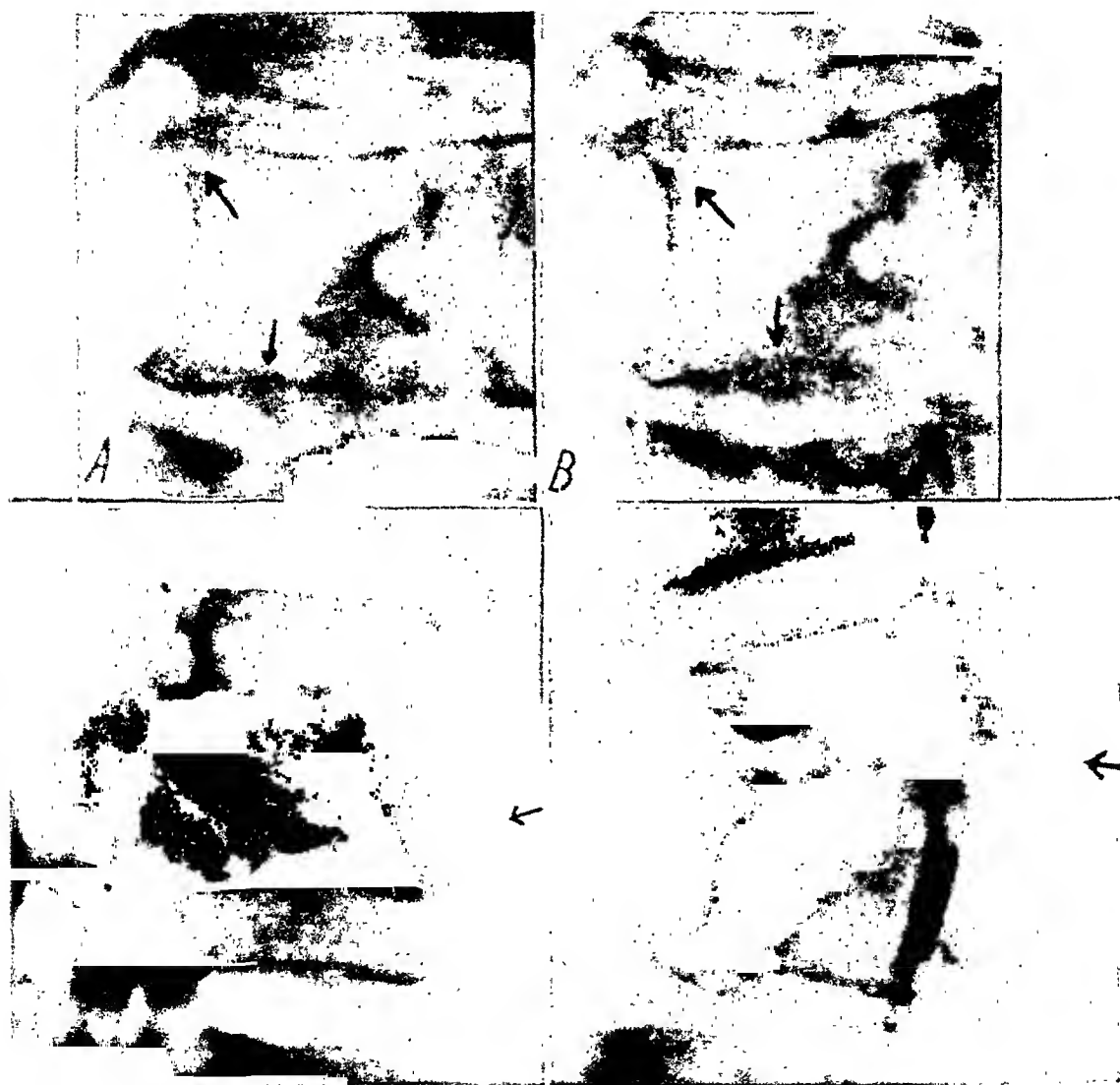


Fig. 1. Involvement of vertebral symphysis. Progressive erosion of vertebral margin by infection of undetermined origin, probably undulant fever. There is a three months' interval between A and B. Note progressive erosion and a partial dissolution of contours in B (arrows). Disc space narrowed, ligaments calcified. Lower row: Illustration of symphysis in the presence of bone necrosis.

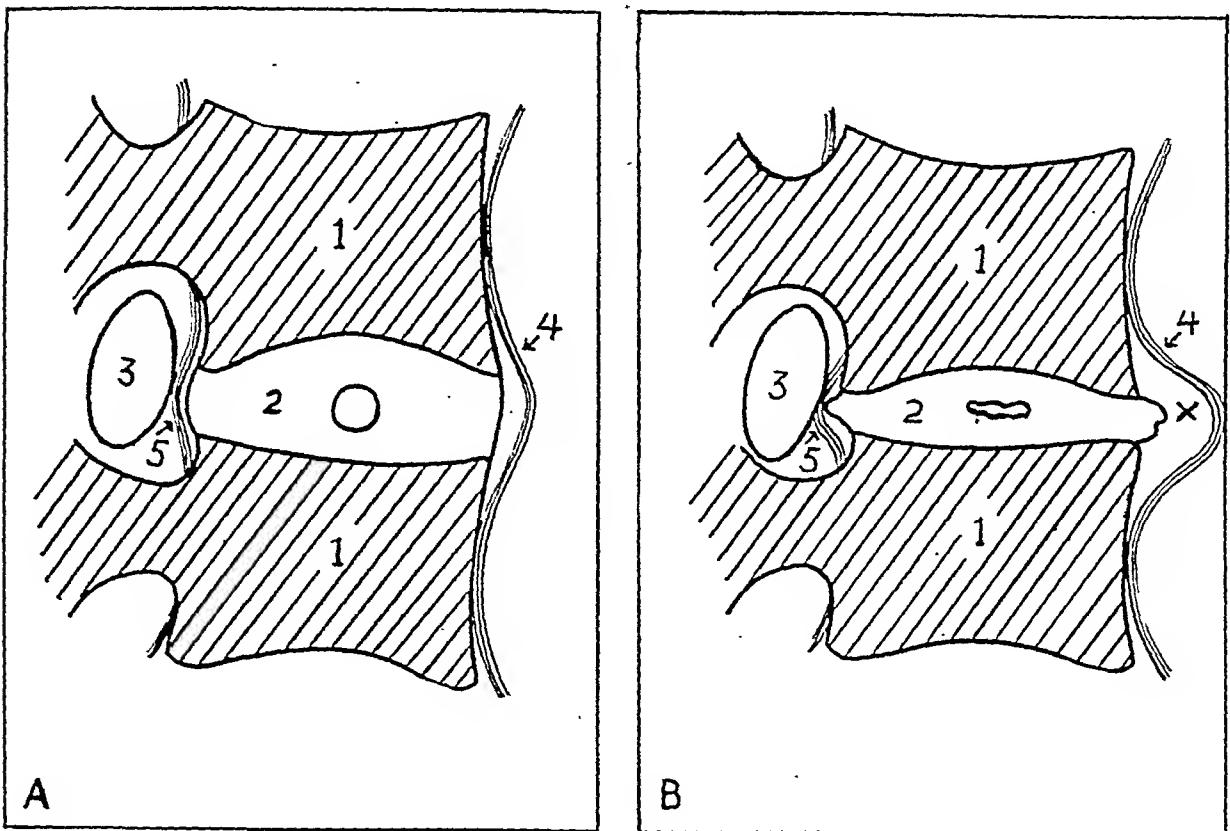


FIG. 5. Semidiagrammatic drawings showing the free space at the vertebral edge (x) into which new bone can grow (see text). *A*, normal, and *B*, in the presence of a thinned disc. 1, vertebral bodies. 2, intervertebral discs. 3, cross section of nerve root. 4, anterior longitudinal ligament. 5, posterior longitudinal ligament. Note increase of free space and decrease of width of neural foramen caused by disc thinning, in *B*.

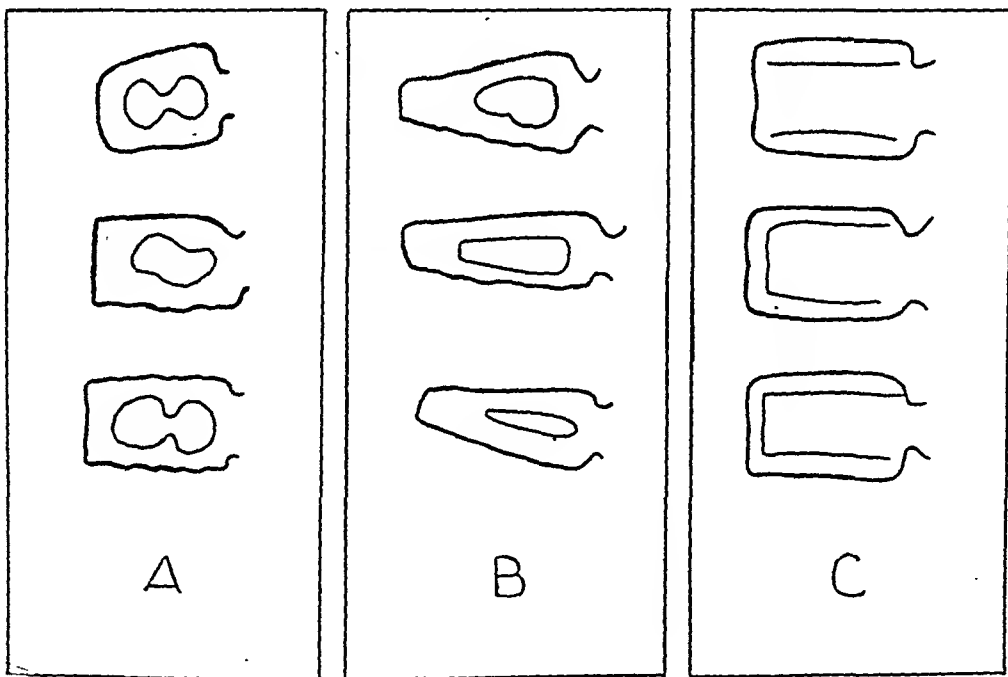


FIG. 6. Tracings of roentgenograms of lumbar spine of a boy, aged six, with severe rickets. The contrast between bone and soft tissues in the original roentgenograms is so poor that reproductions cannot be made satisfactorily. *A*, beginning compression of vertebrae, with clover-leaf shaped defects caused by enlargement of marrow spaces. *B*, three months later, the vertebrae have become thin bone plates separated by very wide interspaces. *C*, healing stage, with ossific lines causing double contours of vertebral bodies.

able that condensation is so common in the vertebrae because rarefaction also is often more pronounced in the spine than in other parts of the skeleton. Possibly the great vascularity of vertebral bone is responsible for this reaction.



FIG. 7. Osteochondrodystrophy.

Bony overgrowth of vertebrae usually occurs along the edge where the horizontal and vertical surfaces meet. These marginal osteophytes, often designated as "lipping," "spiculation," and "osteoarthritis" of the spine, are generally considered a distinctive morbid entity.<sup>1, 10, 11, 12, 13, 14</sup> The findings in this series do not bear out this view. New bone is incapable of growing through normal differentiated connective tissue. Thus

benign osteoma develops only where gaps are present in the periosteum.<sup>2</sup> Although devoid of a periosteum,<sup>21</sup> the vertebral body is surrounded by connective tissue (ligaments and cartilages) except along the vertebral edge. At this site the longitudinal ligaments separate from the vertical vertebral surface before bridging the disc. Consequently there is a triangular space free of connective tissue between bone and ligament, encircling the vertebral edge (Fig. 5). This, then, is the only space into which new bone can grow,<sup>13</sup> unless the ligaments and/or cartilages are torn or destroyed. Consequently osteophytes are usually confined to the vertebral edge no matter what their cause; they develop at this site in the presence of such different lesions as fracture, pyogenic infection, and as a result of the mechanical stimulation produced by thinning of the intervertebral disc (Fig. 2, 4, 5, 10 and 15).

*d. Diseases of Growing Bone.* The lesions arbitrarily included under this heading are a heterogeneous group, having in common only their occurrence in juvenile bone. This group is represented here by rickets, osteochondrodystrophy, and so-called adolescent osteochondritis; but many other lesions also belong in this category.

Rickets of the spine differs from rickets of peripheral bones because of the absence of primary epiphyses in the vertebrae. Consequently, rickets of the spine shows the rachitic lesion in a simplified model, so to speak.<sup>16</sup> Rarefaction causes the vertebral bodies to become compressed, and the enlargement of the medullary space, which is characteristic of rickets,<sup>7</sup> produces central defects in the vertebral bodies.<sup>16</sup> Owing to the associated muscular hypotony the physiologic curves of the spine become lost, to the extent that the lumbar lordosis may be reversed into kyphosis.<sup>22</sup> As in peripheral bones, lines of increased ossific density appear during the healing stages and produce a double contour of the vertebral bodies (Fig. 6).

Osteochondrodystrophy causes the same appearances in the spine as in other bones.

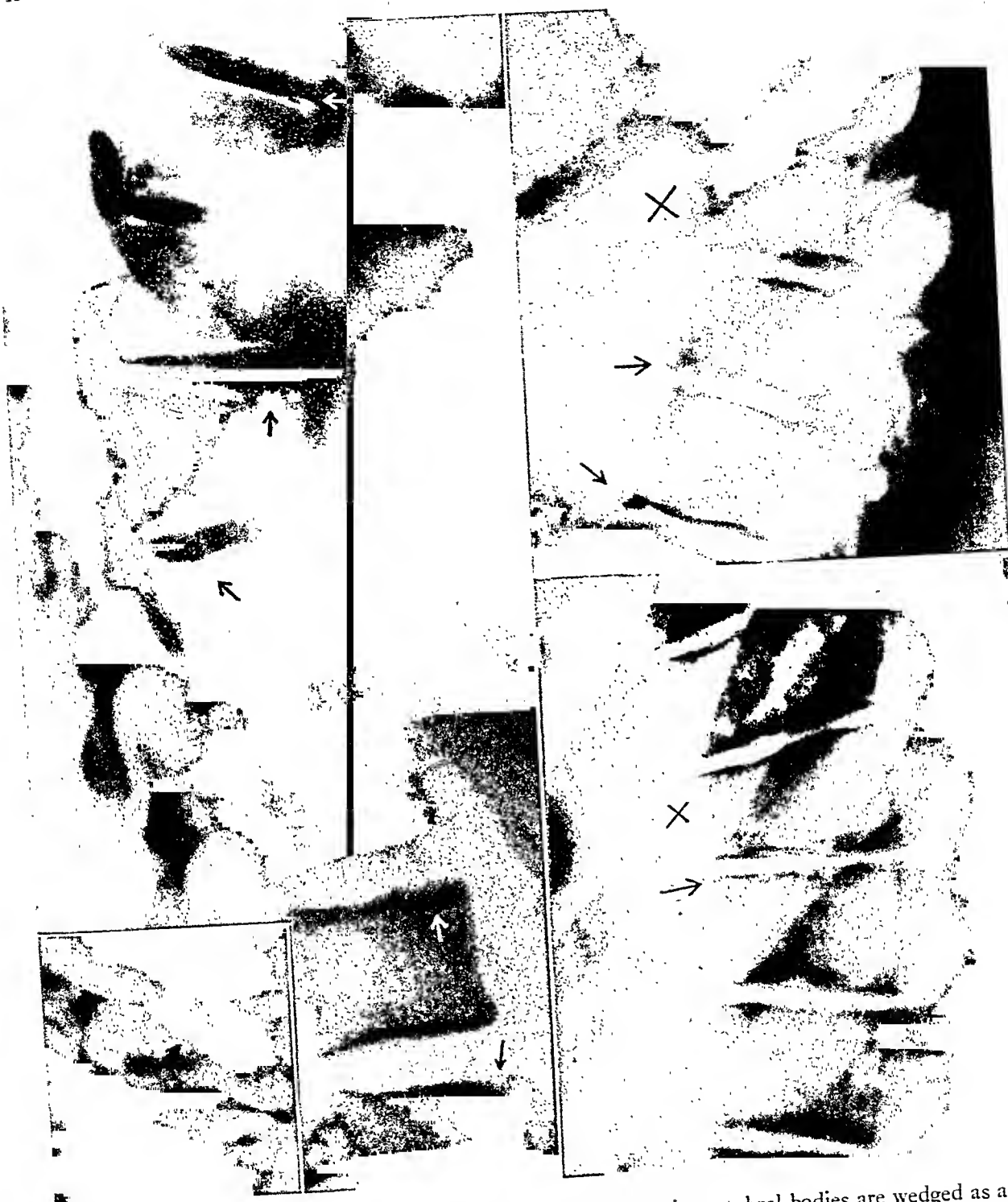


FIG. 8. Adolescent "osteochondritis," or "epiphysitis." The thoracic vertebral bodies are wedged as a result of rarefaction and compression, with scalloping of their horizontal surfaces as a result of protrusion of discs (white arrows). Normal annular epiphyses are present at the uppermost vertebral edges (horizontal black arrows). An abnormal epiphysis, showing fragmentation and surrounding condensation, is seen in the lowest vertebra (vertical black arrow). Insert shows compression of seventh thoracic vertebral body due to protrusion of disc in another case of adolescent osteochondritis. Roentgenograms on the right show osteochondritis at active stage (upper figure) and healed stage (lower figure).

(Fig. 7). There are no characteristic roentgenologic differences corresponding to the clinical varieties of the disease.

Adolescent osteochondritis—of which

Perthes' disease is the best known example—occurs in the spine, as in other bones, at the time when the secondary ossific centers ossify and merge with the main parts of the

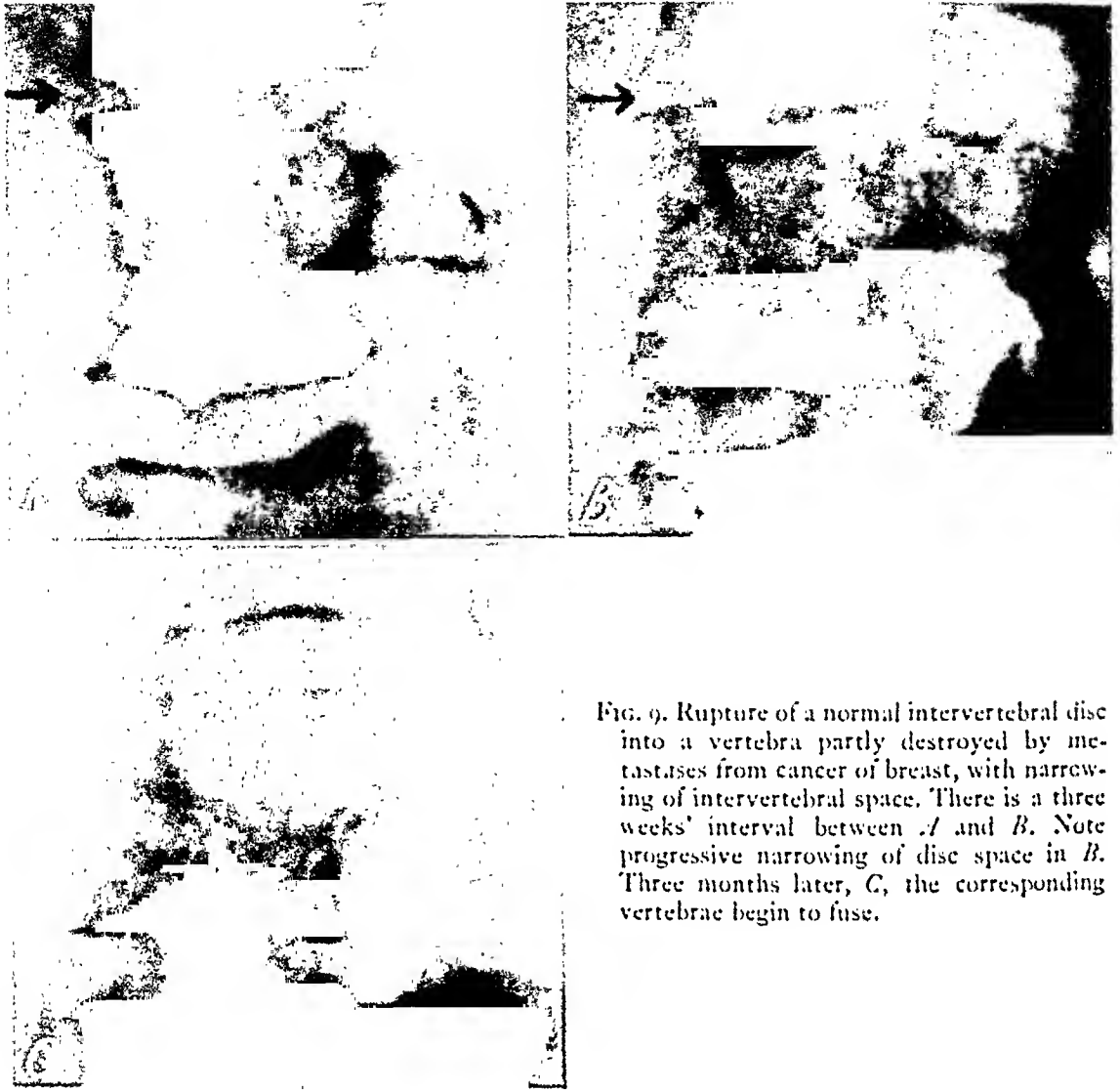


FIG. 9. Rupture of a normal intervertebral disc into a vertebra partly destroyed by metastases from cancer of breast, with narrowing of intervertebral space. There is a three weeks' interval between *A* and *B*. Note progressive narrowing of disc space in *B*. Three months later, *C*, the corresponding vertebrae begin to fuse.

bones. In the spine, these centers, or apophyses,<sup>2</sup> are ring-shaped and encircle the vertebral edge; when ossified and united with the vertebrae, they form the permanent vertebral edges of the adult.<sup>31</sup> A. In the femoral head, osteochondritis produces fragmentation and deformity of these epiphyses. In the lumbar spine the involved epiphyses become easily detached from the anterior margins of the vertebral bodies where the tension of the longitudinal ligaments is strongest; condensation may develop as a secondary reaction (Fig. 8). Almost invariably there is an associated moderate rarefaction of all the vertebral bodies, with wedging of the bodies at the vertex of the thoracic kyphosis, and with protrusion of discs into the yielding bones.

As a rule, the lesion of the epiphyses ("vertebral epiphysitis") is more definite in the lumbar spine than in other regions, while wedging of vertebrae ("adolescent kyphosis," Scheuermann's disease) is confined to the thoracic segments; but the two coexist in practically all cases and seem to represent merely different manifestations of the same disease (Fig. 8).

*c. Bone Tumors, Primary and Metastatic.* Primary bone tumors are rarer in the spine than in most other parts of the skeleton. Angioma, multiple myeloma, giant cell tumor, and Ewing's tumor were recorded in this series. The appearances are well known<sup>32</sup> and need not be discussed here. Tumor metastases have a high incidence in the spine, apparently because of the pecu-

liar topography of the vertebral veins. As already mentioned, osteoplastic (condensing) metastases are especially common in the spine. Contrary to current opinion, the disc spaces may become narrowed in the presence of vertebral metastases as a result of protrusion of the disc into the destroyed bone (Fig. 9). Involvement of the spine by Hodgkin's disease, the leukemias, and the lipoidoses is regarded here as metastatic.

*Comments.* Traumatic bone lesions have not been included, since their appearances are well known. The cystic and fibrosing bone lesions have been omitted because their classification is still debated. For the purpose of this study, the bone lesions had to be classified according to purely roentgenologic criteria, irrespective of clinical considerations. This classification, therefore, is not meant to supersede other accepted classifications based on different principles.

### 3. DISEASES OF VERTEBRAL SYMPHYSES

The articulation formed by two vertebral bodies and the intervening disc is an amphiarthrosis or symphysis according to anatomical texts, and may be designated as vertebral symphysis in order to distinguish it from the synovial joints of the spine.<sup>14</sup> Since every junction of two bones, or of bone and cartilage (including the cranial sutures and the cartilaginous epiphyseal junctions), is considered a joint anatomically, one would expect that lesions of symphyses be grouped with joint disease, or arthritis; but by definition, arthritis is a lesion of only the synovial joints. Since the vertebral symphyses have no synovial membranes, no joint cavities, no free articular cartilages, nor any other parts characteristic of synovial joints, the symphyses cannot be the seat of arthritis. This point is not merely academic, but has clinical implications which will be discussed under heading 6.

There seem to be two main groups of lesions of the vertebral symphyses:

2. Diseases of vertebral symphyses
  - a. Originating in the vertebral bone
  - b. Originating in the vertebral disc

*a. Lesions Originating in Vertebral Bone.* It is held that disc cartilage is impervious to infection and invasion by tumor cells;<sup>20,21</sup> yet there is no doubt that the disc often deteriorates as a result of infection of an adjacent vertebra.<sup>7</sup> Although resistant against tuberculous infection,<sup>1,20</sup> the disc usually becomes necrosed in the presence of tuberculosis of the corresponding vertebral body.<sup>7,23</sup> The records in this series suggest that the disc remains intact, at least for many years (Fig. 1A), when the infection is confined to the central part of the vertebral body; but whenever infection, no matter of what kind (Figs. 2 and 4), involves the vertebral horizontal surfaces, or the regions close to them,<sup>15</sup> the disc grows flat (Fig. 1C). Since during adult life the disc receives its nutrition exclusively from the vertebral body, through the lamina cribrosa,<sup>21</sup> the disc may become involved in these cases because its nutrition is, or was, impaired as a result of the lesion of the underlying bone.<sup>15</sup>

When congenital gaps,<sup>21</sup> traumatic fissures,<sup>20</sup> rarefaction, or necrosis of the horizontal vertebral surface allows parts of the disc to herniate into the vertebral body, proliferation of connective tissue often develops in both the bone and the disc and may gradually invade large areas or all of the disc.<sup>21</sup> This proliferation, being irreversible in cartilage, leads to fibrosis of the involved parts of the disc. When the fibrosed areas are large, loss of volume and of elasticity of the disc is the result, and the disc flattens down.

*b. Lesions Originating in the Vertebral Disc.* Owing to acute trauma, or to the recurrent slight injuries produced by the ordinary wear and tear of posture and motion, a number of "degenerative" changes may occur in the disc, such as fissures, rupture of disc cartilage or of the nucleus pulposus through the external disc layers, and detachment of fibrocartilage.<sup>21</sup> All these lesions lead, at least potentially, to increasing fibrosis of the disc eventually,<sup>20</sup> and the disc becomes flat. Since cartilage cannot be effectively regenerated, the lesion is permanent.



FIG. 10. "Degenerative" flattening of lumbar disc in a patient with severe sciatic pain. Note marginal osteophytes conforming to shape of free space at vertebral edge, and narrowing of neural foramen. Compare with Figure 5.

Flattening of the disc, no matter of what origin, induces a number of secondary alterations.<sup>11</sup>

*c. Secondary Changes.* At the level of a flattened disc the distance between the vertebrae diminishes proportionally. Consequently the corresponding neural foramina grow narrow (Fig. 5, 10 and 15), and the nerve roots which pass through them may become compressed,<sup>12</sup> especially in the cervical and lumbar segments, where the nerve roots are thick.<sup>13</sup> At the same time, the articular processes approach each other and may become subluxated,<sup>14</sup> with the result that their articular cartilages sustain increased stress. Erosion of these cartilages may develop and be followed by reactive changes in the corresponding apophyseal joint.<sup>15</sup> Swelling, thickening, and calcification of the apophyseal joint capsule may then occur and add to the compression of nerve roots in the already narrowed neural foramina.<sup>16</sup> Independently, but sometimes simultaneously, the edges of the vertebral

bodies may come in contact during certain movements, since the discs, which are their natural buffers, are thinned; whereupon minute but recurrent fractures may occur in the vertebral edges,<sup>21</sup> and each fracture may heal with bony callus formation. As the injury recurs, the callus formations multiply, grow larger, and amount finally to osteophytes along the vertebral edges.<sup>12</sup> The common ligaments at the level of a flattened disc grow loose of necessity, owing to reduction of the intervertebral space which they bridge (Fig. 5). Consequently they bulge around the vertebral edge and increase the width of the triangular free space at this site (Fig. 10), thereby allowing osteophytes to grow particularly large (Fig. 15). These various changes, generally but erroneously termed "osteo-arthritis of the spine," may be designated as "dis-cogenic"<sup>15</sup>—that is, produced by involvement of the disc<sup>15</sup>—in order to differentiate them from similar changes which are due to some other cause.

*d. Narrowing of the Intervertebral Space without Involvement of the Disc.* As a rule, narrowing of the space between contiguous vertebral bodies is caused by flattening of the intervening disc; but it may occasionally be the result of bone disease not involving the disc. In the presence of tuberculous and of pyogenic infections of the vertebrae,<sup>1</sup> of severe rarefaction (Fig. 11), and of certain tumor metastases (Fig. 9), the disc may remain intact but protrude, by its own expansibility, into the softened or destroyed bone. When the disc is completely expanded but the bone continues to yield to the weight of superincumbent parts, the softened bone may finally engulf the disc, and contiguous vertebrae may then come in contact (Fig. 3*A*) and become fused along their edges.<sup>7</sup>

*Comments.* The histopathologic varieties of disc "degeneration" have not been classified since they cannot be distinguished roentgenologically. Rupture of the disc into the spinal canal, although clinically significant, is included along with the lesions originating in the disc. Displacement or frag-



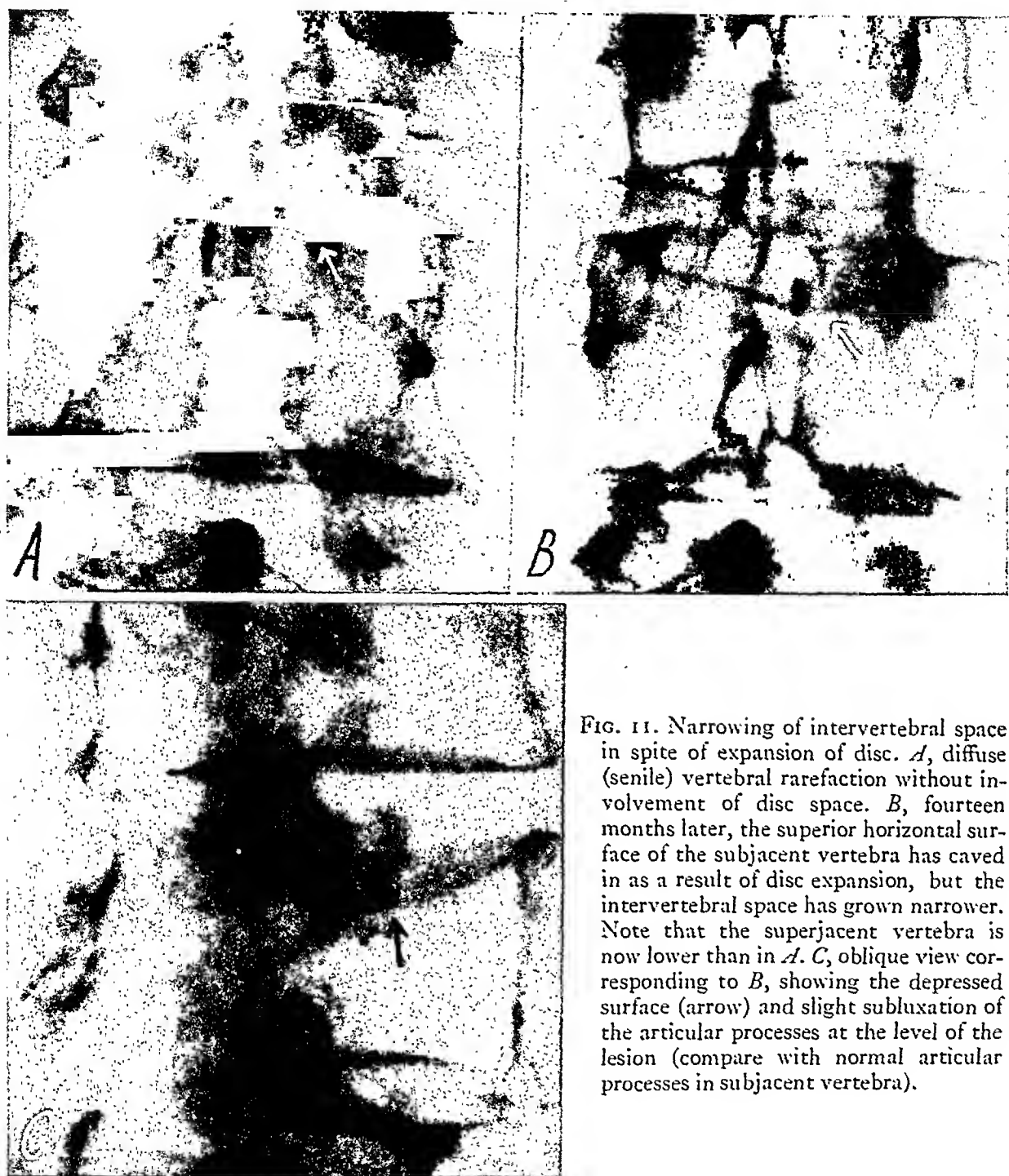


FIG. 11. Narrowing of intervertebral space in spite of expansion of disc. *A*, diffuse (senile) vertebral rarefaction without involvement of disc space. *B*, fourteen months later, the superior horizontal surface of the subjacent vertebra has caved in as a result of disc expansion, but the intervertebral space has grown narrower. Note that the superjacent vertebra is now lower than in *A*. *C*, oblique view corresponding to *B*, showing the depressed surface (arrow) and slight subluxation of the articular processes at the level of the lesion (compare with normal articular processes in subjacent vertebra).

mentation of the nucleus pulposus is not demonstrable on roentgenograms and is regarded as an incidental change.

#### 4. DISEASES OF VERTEBRAL SYNOVIAL JOINTS

The apophyseal ("small," "posterior") joints, which connect the facets of contiguous articular processes, are synovial joints like the peripheral joints. Their lesions conform to the definition of arthritis<sup>10</sup> and may be classified as follows:

#### 3. Diseases of vertebral synovial joints

- a. Acute arthritis
- b. Rheumatoid (atrophic) arthritis
- c. Osteo-arthritis (hypertrophic arthritis, degenerative joint disease)
- d. Secondary involvement

a. *Acute Arthritis*. This is marked by transient swelling of the apophyseal joint capsule.<sup>10</sup> In some instances the subchondral areas of the involved articular processes undergo slight rarefaction.<sup>10,11</sup> Together

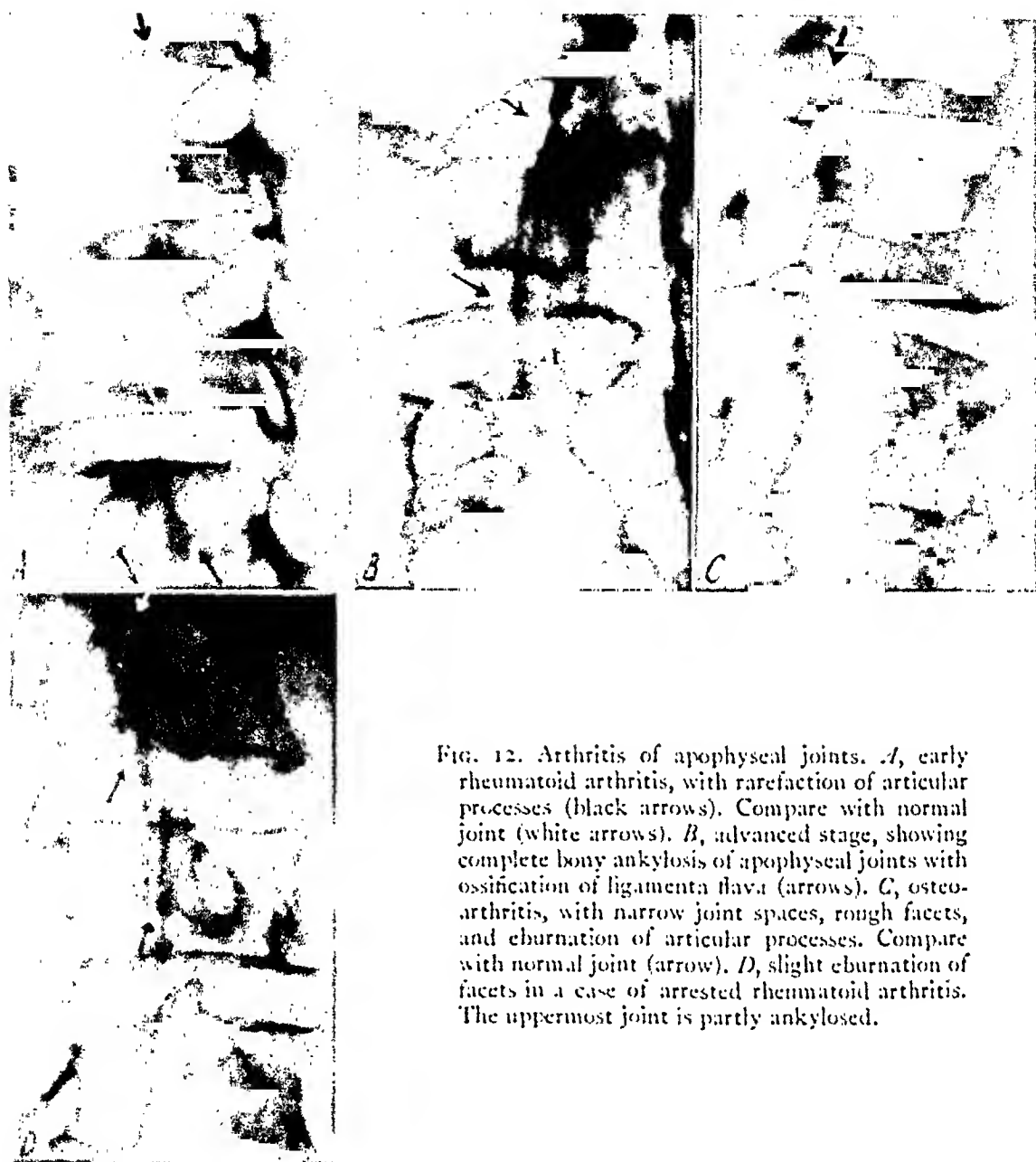


FIG. 12. Arthritis of apophyseal joints. *A*, early rheumatoid arthritis, with rarefaction of articular processes (black arrows). Compare with normal joint (white arrows). *B*, advanced stage, showing complete bony ankylosis of apophyseal joints with ossification of ligamenta flava (arrows). *C*, osteoarthritis, with narrow joint spaces, rough facets, and eburnation of articular processes. Compare with normal joint (arrow). *D*, slight eburnation of facets in a case of arrested rheumatoid arthritis. The uppermost joint is partly ankylosed.

with the occasional development of rheumatoid arthritis subsequent to acute arthritis, this is somewhat suggestive of an interrelation between the acute and rheumatoid type.<sup>12</sup> Acute spondylarthritis, which is usually confined to one or two apophyseal joints, subsides after a number of weeks in most cases, and the involved joint spaces and articular processes resume normal physiologic appearances.

*2. Rheumatoid Arthritis.* Rheumatoid arthritis of the apophyseal joints has the same histopathologic features as periph-

eral rheumatoid arthritis.<sup>14</sup> Roentgenologically, rarefaction of articular processes with narrowing of the intervening joint space (Fig. 12*A*) is noted at early stages.<sup>15,16,17</sup> The disease may evolve rapidly towards complete<sup>18</sup> or circling<sup>19</sup> bony ankylosis of the involved apophyseal joints; or it may become arrested before ankylosis has taken place,<sup>16</sup> in which case secondary reactions—such as roughening and condensation of the eroded facets<sup>15</sup>—may supervene (Fig. 12*D* and 13). As a rule, rheumatoid spondylarthritis involves a number of apophyseal



FIG. 13. Rheumatoid arthritis, confined to sacroiliacs and a pair of apophyseal joints in one single vertebral segment. *A*, fourth lumbar segment, right side, showing almost complete ankylosis of the joint (arrow). Compare with adjacent joints. *B*, same segment, left side, showing slight narrowing of joint with thorn-shaped osteophyte at tip of articular process, as a result of secondary osteo-arthritic reactions. *C*, sagittal view, showing involvement of sacroiliacs. Although only one pair of joints was involved, the patient was incapacitated with pain and complete rigidity of spine.

joints either simultaneously or successively and may finally affect the entire vertebral column; peripheral joints may then become ankylosed (Strümpell-Marie's disease); but the lesion may also remain confined to one single apophyseal joint,<sup>14</sup> or to a pair of joints in one vertebral segment (Fig. 13). The ligamenta flava, which merge with the joint capsules, may become ossified together with the joint capsules during the ankylosing phase of the disease (Fig. 12*B*). In about one-third of all cases, the longitud-

inal ligaments also become ossified at advanced stages<sup>7,13,14,21</sup>—hence the name, spondylitis ossificans ligamentosa.<sup>7</sup> Rarefaction of vertebral bodies is often noted during active phases of the disease and seems to correspond to the para-articular rarefaction of peripheral bones observed in the presence of peripheral rheumatoid arthritis; as the apophyseal arthritis progresses and becomes less active, the vertebral bone usually regains normal density.<sup>11</sup>

*c. Osteo-arthritis.* The anatomic findings

in osteo-arthritis of apophyseal joints do not differ from those of osteo-arthritis of peripheral joints.<sup>14-16</sup> Eburnation of the facets, osteophytes at the tips of the articular processes, and narrowing of the apophyseal joint space are seen on roentgenograms (Fig. 12C). These changes may develop during quiescent and arrested stages of rheumatoid arthritis, as already mentioned (Fig. 12D and 13B); this corresponds to the secondary osteo-arthritic reactions seen in the presence of arrested rheumatoid

sometimes involves the cervical apophyseal joints,<sup>7</sup> is considered here a secondary invasion in the presence of vertebral bone tuberculosis.

#### 5. DISEASES OF VERTEBRAL LIGAMENTS

Not much has been written about the pathology of ligaments in general. The vertebral ligaments may be torn, and detached from the bone, as a result of trauma. Necrosis of vertebral ligaments may occur in the presence of vertebral bone necrosis, such as

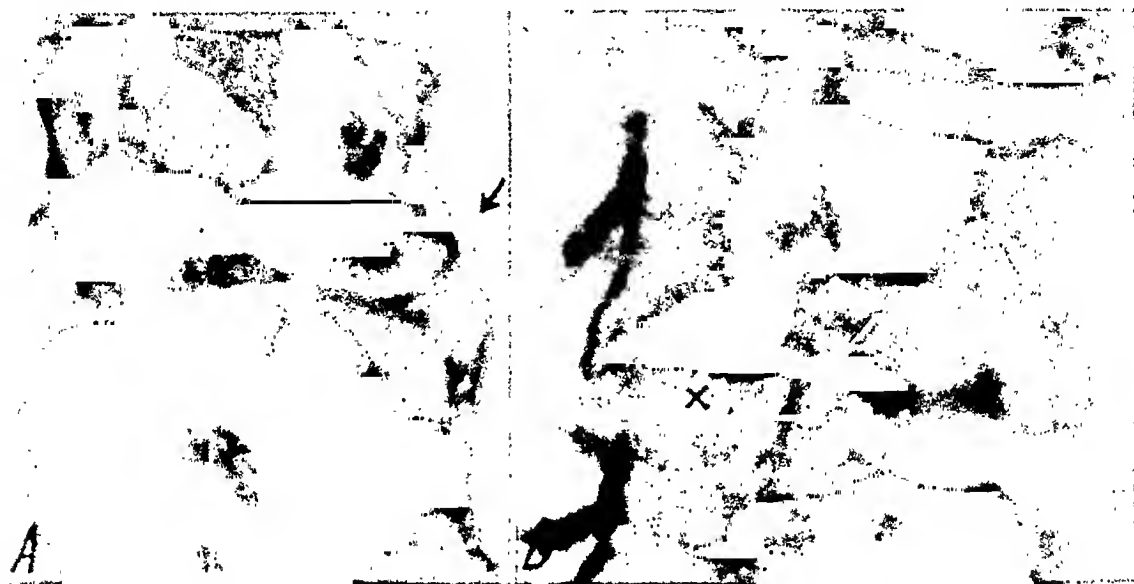


FIG. 12. Secondary involvement of apophyseal joint by pyogenic infection of vertebral body. The vertebral bodies show irregular bone structure with scattered areas of necrosis. One articular process is destroyed (arrow); the contiguous articular process is eroded (arrowhead).

arthritis of peripheral joints. In most cases, however, osteo-arthritis of the apophyseal joints seems to be a consequence of subluxation of the articular processes due to some postural or static abnormality, such as is produced by thinning of the disc, scoliosis, fractures, and the like.<sup>17</sup>

*A. Secondary Involvement.* Infection may spread from the vertebral body into the neural arch, in the articular processes, and finally into the apophyseal joint (Fig. 14 and 15). This is rare.<sup>18</sup>

*Comments.* Gouty, suppurative, and neurotropic (Charcot type) arthritis of the apophyseal joints does not seem to have been reported. Tuberculous arthritis, which

due to tuberculosis,<sup>19</sup> osteomyelitis,<sup>20</sup> and syphilis.<sup>7</sup> These lesions of ligaments cannot be recognized on roentgenograms.

*Ossification and Calcification.* The ligaments calcify or ossify in the spine more frequently and more extensively than in most other parts of the skeleton. Ossification or calcification may occur at healing stages of vertebral bone infections, after fractures of the vertebrae, at advanced stages of rheumatoid spondylarthritis, and in old age (Fig. 4 and 15).

As a general rule, the vertebral ligaments become calcified as a result of disuse. For instance, when the mobility of vertebral regions is permanently diminished owing to

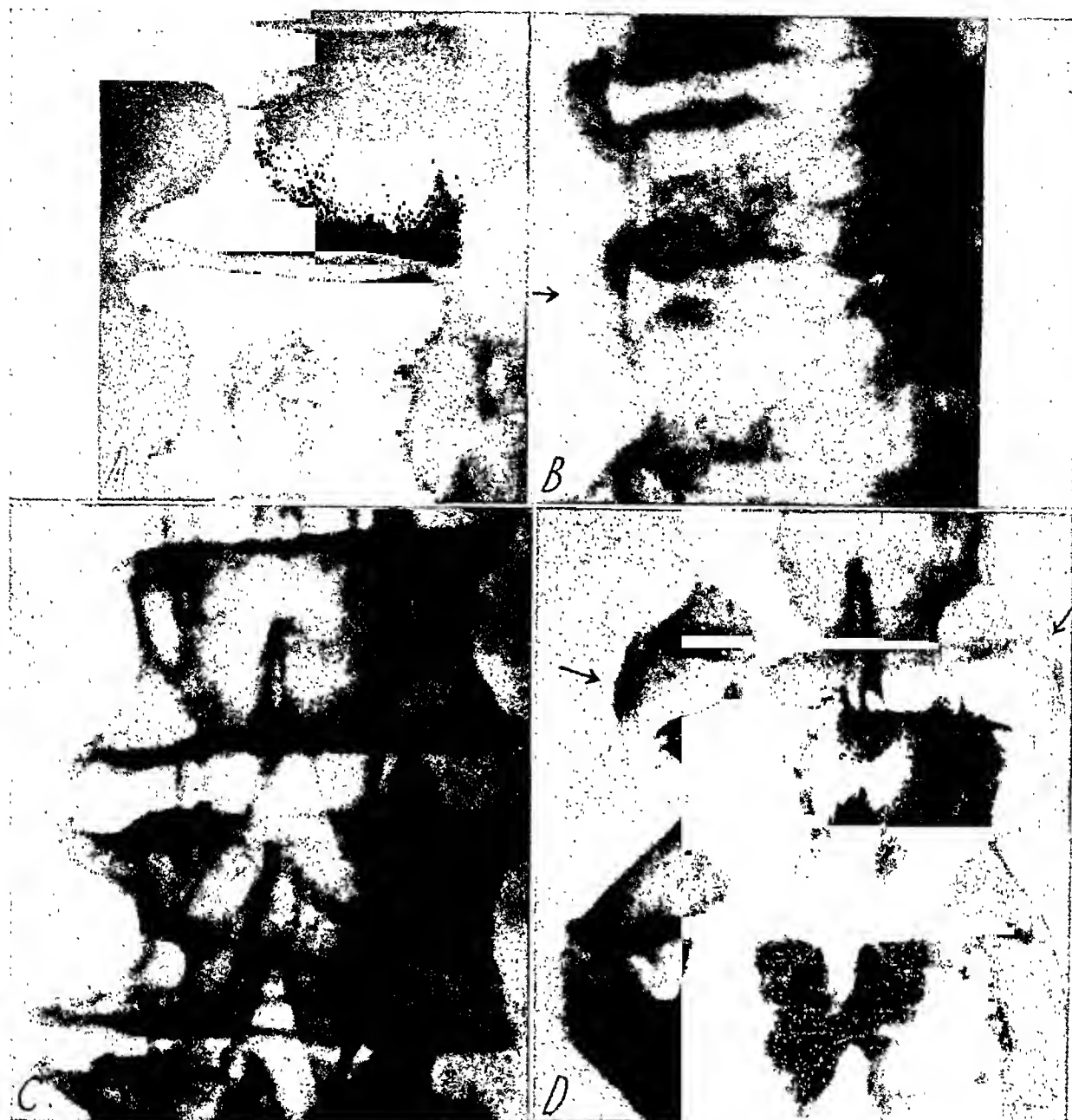


FIG. 15. *A* and *C*, marginal osteophytes at the level of thinned discs. *B* and *D*, ossified ligaments. Note that the osteophytes follow the course of the ligaments at the vertebral edges (see text).

disease or old age, the ligaments undergo calcification. This is nearly always more extensive in the thoracic spine, which has only scant mobility even normally, than in the more movable cervical and lumbar segments.<sup>13</sup> Calcification also occurs often in ligaments which have become relatively too long for the space which they bridge because this space has grown narrow—e.g. at the concave side of scoliotic and of kyphotic regions, and at the level of a narrowed disc space. Apparently, diminished

tension is equivalent to disuse of ligaments.

Ossification of vertebral ligaments in the presence of Strümpell-Marie's disease is always associated with ankylosis of the apophyseal joints and occurs in only about one-third of these cases<sup>14</sup>; hence, it is considered here a secondary phenomenon.

Lesions originating in, and confined to, the vertebral ligaments do not seem to be on record. Morbid changes in the vertebral ligaments appear to be usually the result of disease of some other parts of the vertebrae

without being characteristic of any particular disease or group of diseases.<sup>13</sup>

#### 6. CORRELATIONS WITH CLINICAL FINDINGS

Since this paper is concerned with only the roentgenologic aspects of vertebral disease, the discussion is confined to those correlations between clinical and roentgen findings which are significant for roentgen interpretation.

but not ruptured disc,<sup>6</sup> by thickened and by ossified ligaments,<sup>20</sup> and, of course, by abscess and tumor.<sup>23</sup> Moreover, the clinical manifestations of rupture of the disc into the spinal canal can rarely be distinguished from those caused by compression of nerve roots in the neural foramina.<sup>15</sup> Finally, since in most cases a ruptured disc becomes flat, the neural foramina at this level become narrow, and the symptoms may then be due, at least in part, to compression of

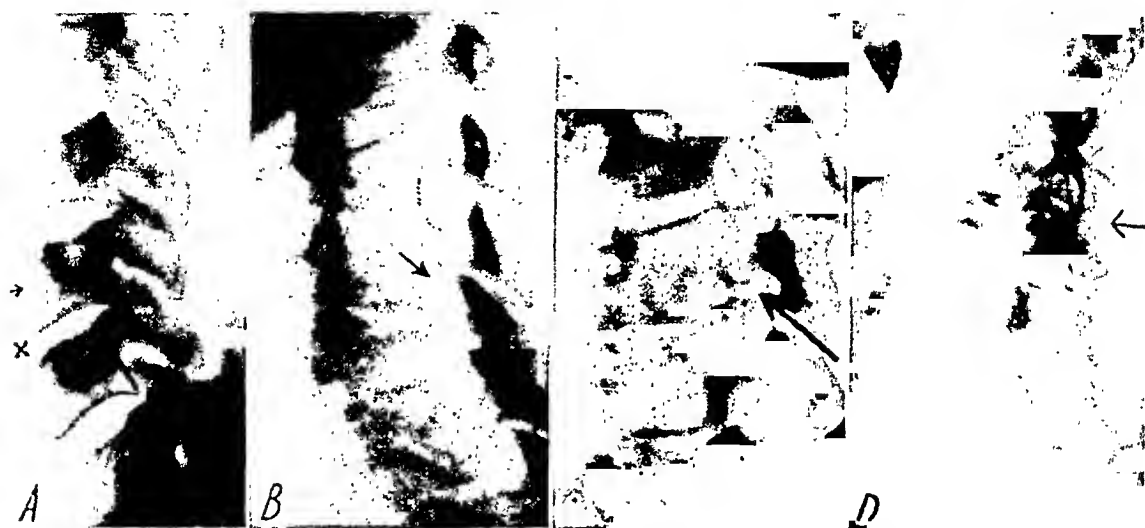


FIG. 16. Narrowing of neural foramina. *A* and *B*, the fifth cervical disc is flattened (*x*). *B*, oblique view to show the displacement of articular processes and narrowing of neural foramen at the level of the flat disc. *C*, osteophytes arising from posterior margins of vertebral bodies, and *D*, from tips of articular processes, encroach upon neural foramina.

*a. Involvement of the Spinal Cord and Its Roots.* Pain in the periphery, sometimes associated with trophic disturbances of the skin, muscles, and bones of the painful region,<sup>12</sup> may be caused either by compression of the spinal cord within the spinal canal, or by compression of nerve roots in the neural foramina.

Rupture of the disc into the spinal canal has come to be considered the most common cause of compression of the spinal cord, although anatomical and roentgenologic studies<sup>9</sup> have shown that clinical manifestations suggestive of disc rupture may also be the result of compression of the cord by osteophytes arising from the posterior surfaces of vertebral bodies,<sup>17</sup> by intraspinal protrusion of a "degenerated"

nerve roots in the neural foramina rather than to compression of the cord in the spinal canal. In the cervical and lumbar segments the nerve roots are thick and fill almost the entire neural foramen<sup>5</sup>; the distance between nerve root and surrounding bone is much smaller than the distance between spinal cord and surrounding bone. Consequently one may say that radicular manifestations are produced by compression of nerve roots more readily than by compression of the spinal cord.

Narrowing of neural foramina may be caused by different vertebral lesions, among which flattening of the disc is perhaps the most common.<sup>15</sup> Osteophytes arising from the posterior borders of the vertebral bodies<sup>3,9</sup> and from the articular processes



FIG. 17. Range of flexion and extension in cervical spine. *A*, normal. *B*, range of motion almost normal in spite of flattening of discs (arrows) and marginal osteophytes; apophyseal joints not involved. *C*, definite limitation of motion in the presence of normal discs but with apophyseal joints involved by osteo-arthritis (arrows). See text.

(Fig. 16); thickening and calcification of the apophyseal joint capsule<sup>10</sup> and of ligaments<sup>10,20</sup>; and subluxation of the articular processes<sup>5</sup> may also produce, or contribute to, compression of nerve roots. According

to anatomical<sup>5</sup> and clinical<sup>12</sup> observations, the changes in and around the neural foramina disclosed on roentgenograms in these cases are actually responsible for the damage of the corresponding nerve roots.



Before considering surgical treatment for a lesion supposedly involving the spinal cord, one should make certain that the signs and symptoms are not produced by compression of nerve roots in the neural foramina. In this series clinical manifestations consistent with radicular neuritis were due to compression of nerve roots in 88 per cent of the cases, and to compression of the spinal cord in 12 per cent.

*b. Limitation of Vertebral Movements.* The mechanisms of vertebral motion are complex and variable. Extravertebral factors—such as the size of the chest, the amount of adipose tissue, and the spatial relations between ribs and pelvis—play a more important part than one would expect. In the cervical region, where these extrinsic

factors are relatively insignificant, the mechanics of the spine can be studied more accurately than in other segments.\*

The range of motion in the cervical spine varies individually and diminishes slightly with advancing years, but remains nearly constant from the third to the fifth decade. About 35 per cent of the patients with lesions of the vertebral symphyses (especially thinning of cervical discs) have a moderately diminished range of motion as compared with healthy persons of the same age group (Fig. 17); but in the remaining 65 per cent the range of motion is within normal limits, no matter whether osteophytes are present or absent at the corresponding

\* The findings relating to vertebral motion are reported separately.

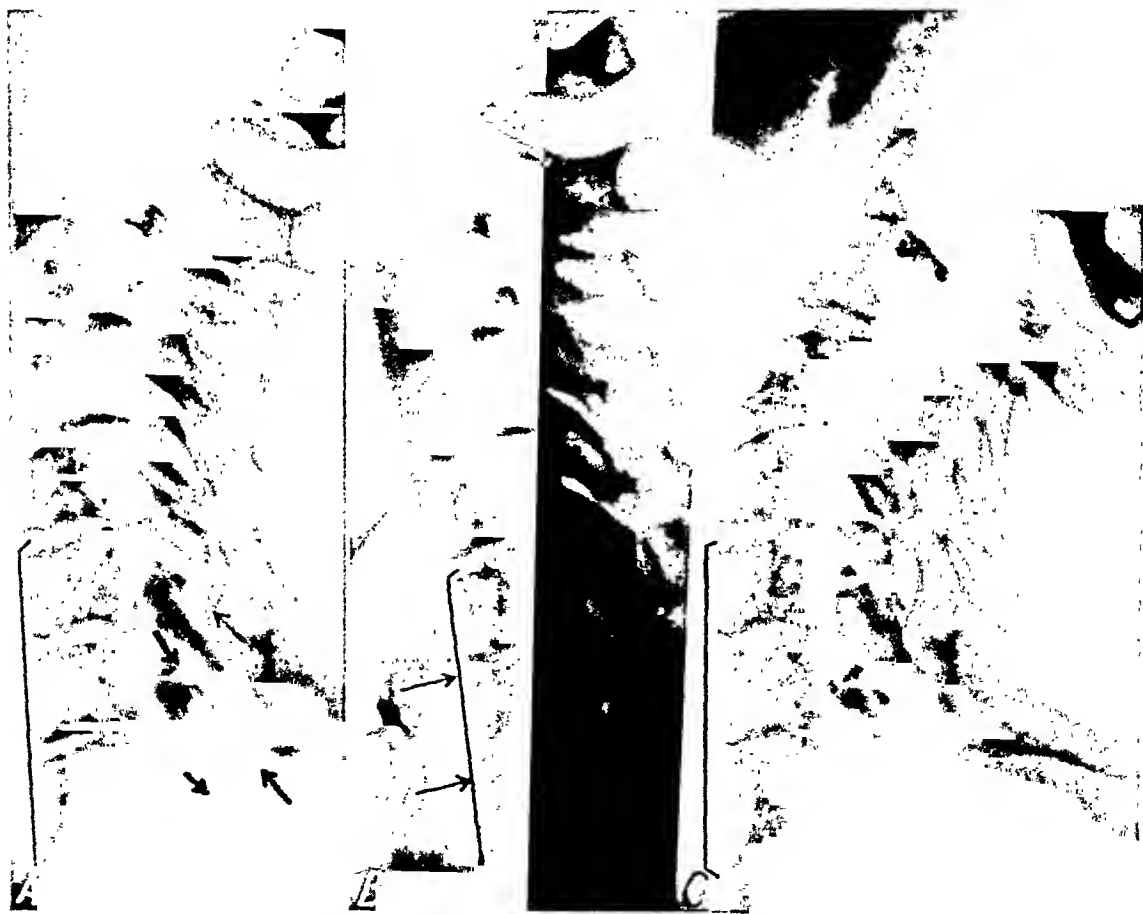


FIG. 18. *A*, all the cervical discs are flattened, but only the lower three apophyseal joints are involved. Note blurred outlines and narrowing of joint spaces (white arrows). *B*, forward flexion, and *C*, backward extension, showing movements practically normal in the segments with flat discs but normal apophyseal joints, while the vertebrae with involvement of apophyseal joints are almost immovable.



FIG. 19. *A*, roentgenogram of cervical spine, and *B*, photograph, of a sixteen year old Arab boy with rheumatoid arthritis of apophyseal joints, advanced stage. Complete immobility of neck. Only the upward motion of the eyeballs discloses the intention to stretch the neck backward. Note incomplete ankylosis of apophyseal joints with ossification of ligamenta flava. No trace of ossification of longitudinal ligaments; no involvement of discs and vertebral bodies. This shows the dominant part which the apophyseal joints play in the control of vertebral motion.

vertebral edges. When, however, the apophyseal joints have become involved secondarily, as a result of the "discogenetic" displacement of their facets, motion is definitely limited in most cases (Fig. 18). Restriction of movements, often amounting to immobility, is usually associated with lesions confined to, or originating in, the apophyseal joints (Fig. 17*C*, 18 and 19). As in peripheral joints, rheumatoid arthritis usually produces a greater limitation of movements than osteo-arthritis.

It has also been shown that pain in the involved vertebral regions is almost invariably present at active stages of the various types of apophyseal arthritis.<sup>10,14</sup> The observations indicate that lesions of the apophyseal joints conform to arthritis anatomically and roentgenologically, and that they produce the cardinal clinical manifestations of arthritis, viz., pain and limitation of movements. Thus there is no significant difference between arthritis of

peripheral joints and arthritis of the vertebral synovial joints.

#### 7. CONCLUSIONS

The main object of this study was to try and assign to the different vertebral diseases those places which they should occupy in the pathology of bone and joints, instead of regarding them separately as distinct entities. It was hoped that with this method of approach a better understanding of the pathology of the spine might be achieved. The findings indicate that differences which exist between bone and joint diseases and the same diseases involving the vertebral column are due merely to the particular anatomical structure and static function of the spine.

The various diseases of bone reappear in the vertebrae. Owing to its cancellous structure and abundant blood supply, the vertebral body is involved more frequently than the neural arch. Because of their frailty

relative to the weight they bear, the vertebral bodies undergo collapse and compression in the presence of rarefaction and necrosis more readily than other bones. The absence of connective tissue around the vertebral edge is responsible for the high incidence of marginal overgrowth. The clinical manifestations of vertebral bone disease conform to those of disease of other bones; but signs and symptoms peculiar to vertebral disease may become super-added when the vertebral symphyses become involved.

Lesions of the vertebral symphyses may have their origin either in the bone or in the disc. Bone disease close to, or at, the horizontal vertebral surface usually leads to involvement of the disc, mainly by interference with disc nutrition, as it seems. The disc itself may become diseased in the absence of a bone lesion. In both cases, the disc grows flat, and the distance between the vertebrae diminishes proportionally. This, in itself, does not produce clinical manifestations; it causes neither pain nor limitation of movements. When, however, the apophyseal joints have become involved as a result of the "discogenetic" displacement, pain in the involved region, together with limitation of movements, is apt to appear. At the same time, but independently, narrowing of the neural foramen may lead to compression of nerve roots, provided the root is thick and the narrowing sufficiently marked; and manifestations of radicular neuritis develop. As a rule, compression of nerve roots has a much higher incidence than involvement of the apophyseal joints in the presence of lesions of the symphyses; hence the conspicuous predominance of symptoms felt in the periphery over symptoms felt in the spine in this group of cases.<sup>15</sup> When neither the nerve roots nor the apophyseal joints are affected, lesions of the vertebral symphyses usually remain silent, unless there is a herniation of the disc into the spinal canal.

The various forms and phases of arthritis occur in the apophyseal joints and are asso-

ciated with the main clinical manifestations of arthritis, viz., pain in the involved region and limitation of its movements. The range of motion of the spine is controlled by the apophyseal joints, but not by the symphyses. Evidence of nerve root involvement may be noted when the nerve roots become compressed by the inflammatory, fibrous, or bony changes caused by the arthritic process.

Of the lesions of the vertebral ligaments, only calcification and ossification are disclosed roentgenologically. These are common reactions, not characteristic of any particular disease, and are apparently the result mainly of disuse of ligaments. They do not seem to produce clinical manifestations; but the signs and symptoms of the vertebral disease which has caused calcification or ossification may be present.

It would seem that the clinical manifestations of vertebral diseases depend not so much on the nature of the lesion as on the involvement of the different parts of the vertebrae and on the level of the morbid process. For example, when bone disease involves the apophyseal joints, the manifestations of arthritis become added to those of osteitis, and so forth. Again, as regards the level of the lesion, narrowing of neural foramina is clinically significant mainly in the cervical and lumbar regions, where the nerve roots are thick, but often fails to cause symptoms when the thoracic spine, with its thin nerve roots, is involved. Similarly, apophyseal arthritis is less disabling in the thoracic spine, which has scant mobility, than in the more movable cervical and lumbar regions. Factors of this kind should be taken into account when evaluating the clinical significance of the roentgen findings; for they would seem to explain, at least in some measure, the discrepancy between the incidence of anatomical lesions and the incidence of clinical manifestations in disease of the spine.

## 8. SUMMARY

1. The diseases of the spine are regarded as vertebral localizations of bone and joint

disease and are classified as (1) diseases of vertebral bone (spondylosteitis); (2) diseases of vertebral symphyses; (3) diseases of vertebral synovial joints (spondylarthrititis); (4) diseases of vertebral ligaments.

2. In general, the morphologic appearances and clinical manifestations of a given vertebral disease correspond to those of the same disease involving other bones and joints. Accordingly, there does not seem to be a definite need for a separate classification of vertebral diseases.

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# THE IMPORTANCE OF EXAMINATION OF THE SPUTUM IN EVALUATING PARENCHYMAL INFILTRATION\*

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IN AN article<sup>1</sup> in a recent issue of the JOURNAL, I presented certain specific cases where the diagnosis of pulmonary tuberculosis was made on roentgen changes *per se* which subsequently proved to be non-tuberculous in origin and character.

The late Lawrason Brown wisely stated that "tuberculosis is seen and not heard." The 1940 edition of Diagnostic Standards of the National Tuberculosis Association<sup>2</sup> states, "the x-ray is the foundation of the early diagnosis of pulmonary tuberculosis." The roentgenogram usually depicts changes which may be considered with some degree of certainty as being due to pulmonary tuberculosis. The early infiltrate, the exudative process, the exudative-productive, caseous pneumonic, ulcerative, productive, fibrotic and calcareous lesion may be the photographic expression of the pathologico-anatomical tuberculous pulmonary change. However, identical roentgen findings may be seen in pathologic entities not due to pulmonary tuberculosis. Because of the similarity of roentgen findings in tuberculous and non-tuberculous pulmonary conditions, roentgen changes produced by tuberculosis of the lungs cannot be considered pathognomonic for that disease.

There is a symptom complex that is usually associated with active pulmonary tuberculosis. Nevertheless, the dry or productive cough, the streaked sputum, hemoptysis, fever, pleurisy, loss of weight, malaise and associated symptoms are often seen in patients with abnormal roentgen findings not due to pulmonary tuberculosis. Still, the occurrence of these symptoms,

singly or in combination, particularly in the presence of abnormal roentgen findings, immediately leads to the diagnosis of pulmonary tuberculosis, even though tubercle bacilli have never been found in the sputum.

The 1940 edition of Diagnostic Standards states that in a patient "with a demonstrable parenchymal infiltration in the lung that is apparently active, when tubercle bacilli cannot be demonstrated, there is probably a non-tuberculous lesion." In the presence of open pulmonary tuberculosis or active ulcerative endobronchial tuberculosis, tubercle bacilli are found in the sputum by the usual methods of identification. Where there is a failure to demonstrate tubercle bacilli at any time in the sputum originating from below the bifurcation of the trachea, the phthisiologist should immediately consider the probable presence of a non-tuberculous pulmonary condition, regardless of suggestive tuberculous roentgen changes.<sup>1</sup>

## DISCUSSION

Table 1 represents an analytical study of 18 cases which were referred to the Sanatorium of the Jewish Consumptives' Relief Society at Spivak, Colorado, with the pre-admission diagnosis of pulmonary tuberculosis in various stages of the disease. A number of these patients had symptoms that could easily be construed as being due to active pulmonary tuberculosis. Of the 18 patients, 14 had a productive cough varying from slight to severe in intensity. Symptoms of bronchial irritation were entirely absent in the patients with sarcoma of the mediastinum, aleukemic lymphatic leukemia with lung infiltrations and Boeck's sarcoid, respectively. Subfebrile

<sup>1</sup> Rest, A. Roentgenogram and some chronic non-tuberculous pulmonary conditions. AM. J. ROENTGENOL. & RAD. THERAPY, 1944, 56, 434-437.

<sup>2</sup> Diagnostic Standards of National Tuberculosis Association, 1940.

\* From the Medical Department of the Sanatorium of the Jewish Consumptives' Relief Society, Spivak, Colo.

TABLE I  
ANALYSIS OF EIGHTEEN PATIENTS WITH NON-TUBERCULOUS PULMONARY  
CONDITIONS DIAGNOSED AS TUBERCULOSIS

Case No. and Sex	Age	Pre-admission Diagnosis	Symptoms upon Admission	Roentgen Findings	Sputum	Subsequent Diagnosis
1 M	29	F.A.B. Miliary T <sub>3</sub> R <sub>3</sub> L <sub>3</sub>	Marked fatigue, dyspnea	Extensive bilateral infiltrations	Negative	Aleukemic lymphatic leukemia*
2 F	31	Min. A. T <sub>1</sub> R <sub>1</sub> L <sub>0</sub>	Moderate cough and expectoration; subfebrile temperature	Small mottling off rt. hilum; linear densities along 1st and 2nd interspace trunks	Negative	Hodgkin's disease
3 F	33	F.A.A. T <sub>3</sub> R <sub>3</sub> L <sub>3</sub>	Productive cough with streaked sputum; dyspnea; left-sided pleurisy	Generalized bilateral mottling; enlargement of heart	Negative	Mitral stenosis and insufficiency
4 M	56	F.A.A. T <sub>3</sub> R <sub>2</sub> L <sub>2</sub>	Severe cough and expectoration; repeated hemoptyses; subfebrile temperature	Hazy dense shadows in both bases	Negative	Bilateral non-tuberculous bronchiectasis
5 M	43	F.A.A. T <sub>3</sub> R <sub>0</sub> L <sub>3</sub>	Slight productive cough; subfeb. temp.; streaking; chills and night sweats; left-sided pleuritic pain	Irregular rounded opaque shadow in left upper lobe	Negative	Sarcoma of mediastinum
6 M	23	Mod. A.B. T <sub>1</sub> R <sub>0</sub> L <sub>2</sub>	Left-sided pleurisy; moder. productive cough; subfebrile temperature	Opaque mass in left upper lobe originating in mediastinum and extending to nipple line	Negative	Sarcoma of mediastinum with metastases
7 M	30	F.A.A. T <sub>3</sub> R <sub>3</sub> L <sub>3</sub>	Severe cough and expectoration; bilateral pleuritic pain	Extensive infiltration in both lungs with exudation; annular shadow in left upper lobe	Negative	Boeck's sarcoid*
8 M	21	F.A.A. T <sub>3</sub> R <sub>3</sub> L <sub>1</sub>	Asymptomatic	Numerous productive nodules in both lung fields, particularly in both midlung fields	Negative	Boeck's sarcoid
9 F	59	F.A.B. T <sub>3</sub> R <sub>3</sub> L <sub>3</sub>	Productive cough; hemoptyses; subfebrile temperature	Infiltrations in major portion of right lung and left upper lobe with annular shadow in left upper lobe	Negative	Hypernephroma* of left kidney with metastases to both lungs and liver; diabetes mellitus; malignant hypertension
10 M	63	F.A.B. T <sub>3</sub> R <sub>3</sub> L <sub>3</sub>	Marked productive cough; dyspnea, hemoptyses	Probable cavity off left hilum; coarse infiltrations in both bases	Negative	Bilateral non-tuberculous bronchiectasis
11 F	54	F.A.A. T <sub>3</sub> R <sub>3</sub> L <sub>3</sub>	Severe productive cough	Scattered areas of infiltration in both lungs	Negative	Bilateral non-tuberculous bronchiectasis
12 M	52	Mod. A.B. T <sub>1</sub> R <sub>0</sub> L <sub>2</sub>	Severe productive cough	Dense shadow extending outward from hilum to the chest wall	Negative	Carcinoma of lung*
13 F	69	F.A.A. T <sub>3</sub> R <sub>3</sub> L <sub>3</sub>	Slight cough and expectoration; slight dyspnea; loss of weight	Dense shadow off right hilum; coarse nodules throughout both lungs	Negative	Carcinoma of lung
14 M	56	Mod. A.A. T <sub>2</sub> R <sub>2</sub> L <sub>0</sub>	Severe cough and expectoration; subfebrile temp.; malaise, loss of weight	Opaque shadow in right upper lobe	Negative	Carcinoma of lung
15 M	65	Mod. A.B. T <sub>2</sub> R <sub>0</sub> L <sub>2</sub>	Severe productive cough; subfebrile temperature; dyspnea; loss of weight	Opaque wedge-shaped shadow off left hilum	Negative	Carcinoma of lung
16 M	60	Mod. A.A. T <sub>2</sub> R <sub>2</sub> L <sub>0</sub>	Slight productive cough; subfeb. temp.; extreme weakness; loss of weight; dyspnea	Large oval shaped opaque shadow in right upper lobe	Negative	Carcinoma of lung; hyperthyroidism
17 M	26	F.A.A. T <sub>3</sub> R <sub>3</sub> L <sub>3</sub>	Slight productive cough	Massive bilateral fine infiltrations apex to base	Negative	Calcicosis of lungs*
18 M	42	F.A.A. T <sub>3</sub> R <sub>3</sub> L <sub>3</sub>	Severe productive cough, marked dyspnea, cyanosis	Scattered areas of infiltration and fibrosis with cavitation right upper lobe; fibrosis left upper lobe	Negative	Ayerza's disease

\* These cases form the basis for the previous article.<sup>1</sup>

The classifications used were those of the National Tuberculosis Association as described in the Diagnostic Standards of the National Tuberculosis Association\* which divides tuberculous lesions into minimal, moderately advanced and far advanced, respectively, depending on degree of involvement. The minimal lesion involves one-third of the volume of one lung without cavitation, the moderately advanced is more extensive than one-third the volume of one lung and not greater than the volume of one lung with cavitation not larger than one interspace. The far advanced lesion is more extensive than the volume of one lung with cavitation larger than one interspace.

The Turban-Gerhardt classification which was used designates the anatomical distribution of the lesion. For descriptive purposes, T<sub>1</sub> R<sub>1</sub> L<sub>0</sub> signifies a minimal lesion of the right apex with no involvement of the left lung; T<sub>2</sub> R<sub>2</sub> L<sub>0</sub>, a moderately advanced lesion of the right lung with no involvement of the left lung; and T<sub>3</sub> R<sub>3</sub> L<sub>3</sub>, a far advanced lesion of both lungs.

temperature, dyspnea, streaking, hemoptysis, pleurisy and malaise characterized the symptoms of a large number of the cases studied. The roentgenogram showed various changes sufficient to classify the patients from moderately to far advanced, with the exception of the case of Hodgkin's disease, where only minimal changes existed. There were roentgen manifestations that gave the appearance of miliary infiltrations, acinose and acinose-nodose nodules, the dense opacity of extreme fibrosis with localized pachypleuritis, exudative processes and cavitation. Because of the pulmonary and constitutional symptoms and the abnormal roentgen findings, these patients were diagnosed as having pulmonary tuberculosis and were admitted to our sanatorium for treatment. The principal diagnostic feature, namely positive sputum, was absent in all these 18 cases, and because of this finding alone, we were of the opinion that pulmonary tuberculosis did not exist in these patients.

In my previous article<sup>1</sup> I emphasized to the roentgenologist the fact that other lung conditions can produce roentgen changes which can easily be interpreted as due to pulmonary tuberculosis. This presentation is intended to stress the importance of demonstrating the tubercle bacillus in sputum in order to properly evaluate roentgen changes as being due to tuberculosis.

#### SUMMARY

Eighteen cases are presented which had roentgen changes simulating pulmonary tuberculosis, and from these roentgen changes one was classified as minimal, five as moderately advanced, and twelve as far advanced prior to admission to our sanatorium. The roentgen findings were diverse and ranged from minimal to extensive lung changes. Only one was asymptomatic, while all the others had symptoms that varied from marked dyspnea and fatigue to severe productive cough, subfebrile temperature, loss of weight and hemoptysis. However, none of them ever had sputum positive for tubercle bacilli.

Subsequent examinations revealed that four had primary carcinoma of the lung, two had Boeck's sarcoid, two had sarcoma of the mediastinum, three had non-tuberculous bronchiectasis, while the others had aleukemic lymphatic leukemia with lung changes, Hodgkin's disease, mitral stenosis and insufficiency, calcicosis of the lungs and Ayerza's disease respectively.

#### CONCLUSIONS

1. It is well understood that certain non-tuberculous pulmonary conditions may produce roentgen changes in the lungs that are indistinguishable from those produced by tuberculosis.
2. These non-tuberculous lung conditions may even produce clinical symptoms that simulate very closely, if not exactly, the symptoms produced by tuberculosis.
3. The absolute diagnostic feature is the demonstration of the tubercle bacillus in the sputum. We have found axiomatically that when a patient expectorates sputum from below the bifurcation of the trachea, the sputum contains tubercle bacilli if an open lesion of tuberculosis exists. If the sputum has always been negative, search should be made for a non-tuberculous pulmonary condition, regardless of how characteristic the roentgen changes are for tuberculosis.
4. The roentgenologist's diagnosis of the chest roentgenogram for tuberculosis should be presumptive rather than absolute, unless the clinical data reveal that the sputum is positive for tubercle bacilli.
5. Adenocarcinoma of the lung is relatively slow growing and in the early stages may produce very slight pulmonary symptoms and, as shown in my study, may easily be mistaken for inactive or mildly active pulmonary tuberculosis. The presence of a parenchymal lesion in individuals in the fifth or sixth decade who have persistently negative sputum examinations should lead to the investigation for carcinoma, the adeno form of which is apparently responsive to early radical surgery.



# HEMANGIO-ENDOTHELIOMA OF THE DIAPHRAGM

## REPORT OF A FATAL CASE IN AN INFANT

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EWING'S classical description of vascular tumors, particularly the endothelioma group,<sup>1</sup> shows the great difficulty in classifying these tumors. They are rather common in the skin as telangiectasias and are occasionally hereditary (Rendu-Osler-Weber's disease). Occasionally they are seen in other organs, often as incidental findings. They are usually benign. Their occurrence in infancy is rather rare.

Döderlein<sup>2</sup> reports a similar case occurring in an infant. His case is comparable to this one in that they both occurred in the right leaf of the diaphragm and were apparently the cause of death.

H. G.,\* infant baby girl, was born September 13, 1942, at 5:30 A.M. in the Maternity Division of the Binghamton City Hospital at the end of the seventh month of uneventful gestation. The infant was the first child of healthy white American parents. Delivery was normal and the child responded well and appeared perfectly normal. The present and past parental history was negative, especially in regard to telangiectasias and nevi. The birth weight was 5 lb. 10 oz. The infant was breast fed and appeared entirely normal until September 24, the eleventh day of life, at which time the mother noticed a slight grunting noise as the child nursed. The temperature and respirations were normal and no vomiting had occurred. However, the attending physician requested a roentgen examination for the presence of a possible enlargement of the thymus. The following were the roentgenoscopic and roentgenographic findings:

The thorax appears normal in contour. The superior mediastinum is not remarkable and thymic enlargement is apparently not present.

The left diaphragm is normal in position and moves normally with respiration. Normal gas shadows are present below. The heart appears normal in configuration and the pulsations are not unusual. The lower liver margin is clearly defined and in normal position. The lung fields are clear and appear well aerated. The right diaphragm is obscured by a dense shadow triangular in shape with a smooth upper margin occupying the entire cardiophrenic angle from the outer third of the diaphragm to the base of the heart shadow. This shadow appears fixed to both diaphragm and right heart border and does not move on inspiration. In lateral projection the mass is in the anterior portion of the right thorax. The nature of this increased density is not known.

The temperature was not elevated, blood and urine examinations were normal.

On September 27, a definite cyanosis was present. Respirations were increased and there appeared to be some difficulty in swallowing. Vomiting was present and feeding was accomplished with great difficulty. Oxygen was occasionally administered as well as stimulants. A second roentgen examination was made with similar findings, except that both lungs appeared more hazy, possibly due to fluid in the pleural spaces. The course was progressively worse and the child died on the twenty-sixth day apparently of asphyxiation. The laboratory findings had all been negative with the exception of the roentgen findings. The cause of death was not determined ante mortem.

The roentgenologic consultation offered the following possibilities: (1) Middle lobe atelectasis. The shadow was in the anatomical position of the middle lobe but not typical of this condition. (2) Atelectasis of a supernumerary or infracardiac lobe. This could not be ruled out. (3) An inflammatory process or consolidation of lung tissue. This was possible but the absence of fever and normal blood findings were opposed to this diagnosis. (4) Congenital heart lesion. The absence of murmurs was thought evidence against this. (5) Diaphragmatic her-

<sup>1</sup> Ewing, J. *Neoplastic Diseases*. Fourth edition.

<sup>2</sup> Döderlein, H. Ueber ein selten ausgedehntes Hämangiom des Zwerchfells sowie der inneren Brust- und Bauchwand als Todesursache bei einem Neugeborenen. *Zentralbl. f. allg. Path. u. path. Anat.*, 1938, 71, 193-201.

\* This case is presented through the courtesy of Dr. H. I. Johnston of the Obstetrical Staff of the Binghamton City Hospital.

nia through the esophageal hiatus or through the parasternal portal. This was a definite possibility and a barium study was suggested but was not attempted because of the critical condition of the infant. (6) Eventration of the diaphragm. Shadows were not typical. (7) Her-

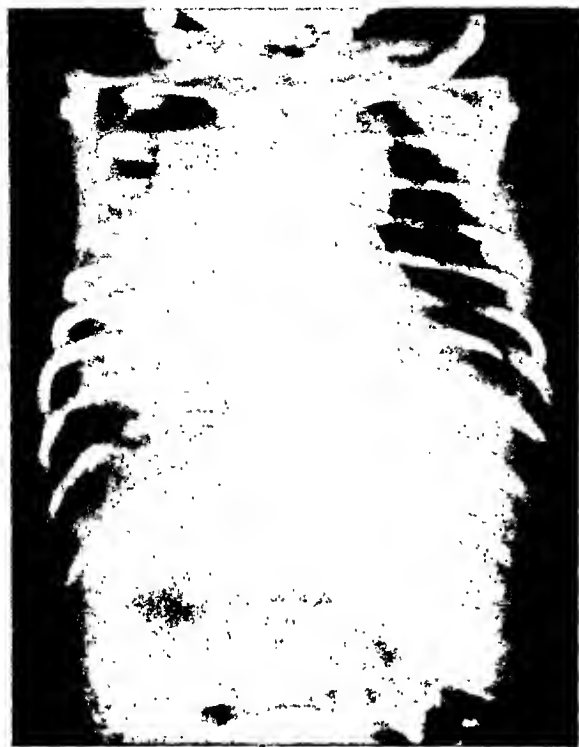


FIG. 1. Triangular shadow of homogeneous density in medial portion of the right lower lung field.

nia of the liver. The lower liver margin appeared normal. (8) Hernia of the pericardium, dermoid cyst and encysted fluid were considered but could not be proved. (9) A tumor of the pericardium, diaphragm or liver was also thought of, as was also the possibility of abnormally situated thymic tissue. The final diagnosis rested upon the postmortem findings.

The pathologist's report follows. Autopsy: H. G., baby girl, aged twenty-six days; American. The body was that of a well developed white female infant weighing 2,100 grams. It was extremely pale and was still warm.

A circular incision was made from shoulder to shoulder around the chest. Difficulty was experienced at once in attempting to remove the chest plate which was unusually adherent and attached to the diaphragm. When this was cut through, the diaphragm was found to measure up to 2 cm. in thickness reaching from the an-

terior attachment to the ribs and sternum to the posterior attachment of the diaphragm and laterally involving about two-thirds of the diaphragm (right leaf). The thickening extended up into the pericardium about two-thirds of which was involved and which appeared to be continuous with the thickening of the diaphragm. In the pericardium this thickening extended up to the reflection around the great vessels. The thymus which was not large could be identified and appeared to be separate from the pericardium from which it could be easily dissected. However, small masses of the tumor tissue appeared to extend into the substance of the thymus. On section, the thickened pericardium and diaphragm consisted of very dark red, very fine spongy tissue, from which some blood could be expressed, and the tissue was definitely resilient. The part of the pericardium



FIG. 2. Shadow appears in anterior portion of the pleural space.

not involved was on the left lateral portion and the heart present in the sac was apparently normal and posterior to the tumor mass. There were no pericardial adhesions. The aorta and the pulmonary artery were markedly compressed by the tumor. Both pleural cavities contained large amounts of yellow fluid which

compressed the lungs, producing extensive atelectasis. The examination of the diaphragm made it possible to inspect the abdominal viscera which were all normal.

Anatomical findings: (1) tumor of diaphragm and pericardium causing compression of the large vessels of the heart; (2) extensive large bilateral pleural effusion causing extensive compression of the lungs; (3) normal thymus, lungs and abdominal viscera.

Microscopical findings: Hemangio-endothe-

lioma confined to the diaphragm and extending into the pericardium with considerable hemosiderin deposited with the sinuses; heart, thymus, adrenals, kidneys, spleen and liver normal; lungs—extreme atelectasis, passive congestion and deposition of hemosiderin.

The above case represents an interesting and extremely rare tumor.

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# RESULTS OF IRRADIATION OF OVARIAN TUMORS\*

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**C**ARCINOMA of the ovary is one of the most fatal of pelvic neoplasms and treatment has always presented difficult problems. Treatment by surgery alone results in a low "cure rate." Our observations and those of others appear to indicate that considerable improvement of this cure rate can be expected by the addition of post-operative irradiation. An accurate com-

TABLE I  
AGE DISTRIBUTION

Years	
20-29	5
30-39	19
40-49	27
50-59	35
60-69	10
70-79	4
Total	100

parison of results reported by different investigators is difficult, however, because of the differences of clinical and pathologic classification of these tumors, as well as the small number of cases which are usually reported.

This paper deals with the results of combined surgical and roentgen treatment of 100 consecutive patients diagnosed clinically or pathologically as having carcinoma of the ovary. They were seen at the University Hospitals from 1930 to 1938, inclusive. Ninety-nine of them were treated from 1930 through 1938, while one patient who was first treated in 1926 received repeated courses of treatment, the last in 1931. All patients were traced and those living have been observed from 60 to more than 155 months. The last communication from all but one of the living patients was received in January, 1944, and this patient was last heard from in November, 1942—more than five years after irradiation.

*Age.* The age distribution is shown in Table I and it can be seen that the majority of cases occurred in the fifth and sixth decades.

*Classification.* Most authors who have reported results of treatment of ovarian tumors have classified their cases in three or four clinical groups. Since the basis of the classification has been the operative findings, the groups are similar. The classification which we have used is essentially that of Heyman<sup>3</sup> who has divided his cases into four groups:

Group I: Those in which removal of the primary tumor and all visible metastases was possible.

Group II: Those who had (a) partial or total removal of the primary lesion but in whom there were visible metastases remaining; or (b) ascites with malignant cells or spill of malignant cells into the peritoneal cavity. (We have added "b" to Heyman's classification.)

Group III. Recurrence of malignant tumor following either operation or irradiation.

Group IV: Inoperable tumor; exploratory operation or paracentesis only; distant metastases.

The distribution of our cases in the four clinical groups is shown in Table II. Twenty-one patients were classified in Group I, 48 in Group II, 8 in Group III and 17 in Group IV. One patient was not classified as she received preoperative irradiation and died three months later of cardiac failure without being operated upon. Five patients had non-malignant tumors and were therefore not classified. These figures show that in 73 patients the tumor had progressed to a stage which required more than surgical removal. Ascites was present in 25 patients.

\* Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24-29, 1944.

Operation, either before or after irradiation, was performed on 94 patients. Four showed such extensive involvement that paracentesis alone was done. One patient had obvious metastases to the vagina and biopsy of only this lesion was taken while one patient was not operated upon.

*Location.* The tumor was unilateral in 46 cases (Table III). Bilateral involvement—either primary or secondary—was found in 30 cases. In 24 cases no information on this point was available. These included those operated upon elsewhere, those who were tapped only and those in whom the operative report failed to mention the site of the neoplasm.

TABLE II  
CLINICAL GROUPS

Group I	21
Group II	48
Group III	8
Group IV	17
Unclassified	1*
Benign tumors and non-neoplastic disease	5
Total	100

\* Patient was given preoperative roentgen therapy and died three months later of heart failure.

*Pathology.* Histopathologic diagnosis was obtained in 98 of the cases. Of the remaining 2, one could not undergo an operation because of heart failure, while the other patient was tapped repeatedly without finding malignant cells in the sediment. Physical examination, however, showed evidence of far advanced abdominal carcinomatosis and the patient died seven months later at home.

As Table IV indicates, there were 91 malignant and 2 potentially malignant neoplasms, 2 benign neoplasms and 3 non-neoplastic conditions. The 2 patients diagnosed as having papillary cystadenomas really had malignant neoplasms since one showed evidence of massive recurrence and died with ascites five years later, while the other showed metastases and adhesions at the time of operation and only a biopsy was taken. In the series with malignant neoplasms, 3 patients came to us with the

TABLE III  
LOCATION

Left	18
Right	28
Bilateral	30*
Not stated	24
Total	100

\* One patient had a papillary cystadenocarcinoma on the left and a Brenner's tumor on the right.

report that a malignant cyst had been removed elsewhere. Papillary cystadenocarcinoma was the most common pathologic finding; the 47 cases make up nearly half of all the malignant neoplasms. The remainder of the malignant neoplasms is divided into 5 carcinomas (all of these cases were operated upon elsewhere but the reports coming from other laboratories could not be checked by us), 21 adenocarcinomas, 9 pseudomucinous cystadenocarcinomas, 1

TABLE IV  
PATHOLOGIC DIAGNOSIS

<b>A. Potentially malignant</b>		
Granulosa cell tumor	1	
Theca cell tumor	1	2
<b>B. Malignant neoplasms</b>		
Carcinoma	5	
Adenocarcinoma	21	
Papillary cystadenoma	2*	
Malignant cyst	3	
Papillary serous cystadenocarcinoma	47	
Pseudomucinous cystadenocarcinoma	9	
Disgerminoma	1	
Teratoma with epidermoid carcinoma	1	
Malignant dermoid cyst	1	
Epidermoid carcinoma	1	91
<b>C. Benign neoplasms</b>		
Fibroma	2	2
<b>D. Non-neoplastic diseases</b>		
Simple serous cyst	1	
Tubo-ovarian abscess	1	
Ectopic pregnancy	1	3
<b>E. Miscellaneous</b>		
No biopsy	1	
No cancer found	1†	2
Total		100

\* The clinical findings and subsequent course in both patients were those of malignant neoplasm.

† This patient was tapped repeatedly, but no neoplastic cells were found in the sediment. The clinical findings and course were those of advanced ovarian neoplasm.

disgerminoma, 1 teratoma with epidermoid carcinoma, 1 malignant dermoid cyst and 1 epidermoid carcinoma. This last diagnosis was made on a patient who came to us with recurrent carcinoma of the omentum and mesentery and who gave a history of having had a malignant ovarian tumor removed twelve years previously. The 2 benign neoplasms were fibromas. These had at first been diagnosed as fibrosarcomas, but review of the sections showed that they were benign. One of these patients had a pleural effusion and the roentgenogram of the chest showed what was thought to be pulmonary metastasis. Postoperative irradiation was given over the chest and the effusion disappeared. Apparently this was a Meigs' syndrome.\* The 3 cases with non-neoplastic diseases were all given preoperative irradiation. One proved to be an ectopic pregnancy, one a tubo-ovarian abscess and the third a simple serous cyst of the ovary. Fortunately these patients were near or past the menopause (40, 53 and 77 years respectively) and no ill effects were noted from the irradiation.

*Treatment.* Ninety-two patients received postoperative and 7 preoperative irradiation. One patient was not operated upon because of heart failure. Of the 7 patients who were treated preoperatively, 3 had ascites and had been classified as inoperable. Following roentgen therapy, the tumor was reduced sufficiently in size so that operation could be performed and at least a portion of the remaining neoplasm removed. In the remaining 4 patients of the preoperative group, the diagnosis was thought to be obvious. Subsequent findings, however, showed that only 1 had carcinoma while the other 3 had non-neoplastic disease.

Irradiation was given with the following factors and techniques: 200 kv. (peak), 5, 8 or 20 ma., 50 cm. focus-skin distance, 0.5 mm. Cu plus 1.0 mm. Al (half-value layer

0.95 mm. Cu), or Thoraeus filter (half-value layer 1.95 mm. Cu). From 1930 through 1935, the pelvis was irradiated through one anterior and one posterior 20 by 20 cm. or 15 by 20 cm. field. In 1936, two lateral 10 by 15 cm. fields were added. Since then, two anterior and two posterior 10 by 15 cm. fields were irradiated instead of the single large fields and most patients were treated in this manner. A few, however, were still treated through the large single fields. When there was definite evidence that the patients had upper abdominal or hepatic metastases, these regions were also treated, usually through one anterior and one posterior 10 by 15 cm. field. An occasional 8 by 10 cm. perineal field was added.

A dose of 200 roentgens (air) was given to each of two fields daily for six days a week. The total air dose to each field varied from 200 to 5,500 r. Only 5 cases received less than 1,000 r (air) to each field in a single series, while not more than 2,000 r (air) was given to each field in a single series. Twenty-five patients received two or three series of treatments over periods of from six to twelve months. Three patients were given two or three courses over longer intervals of time because of recurrence.

With one exception, all patients were given what was believed to be the optimum amount of irradiation and all tolerated the treatments well. The exception was a woman who by mistake was discharged after the first day's treatment. We were not influenced by the clinical or pathologic findings in outlining the treatment for these patients. If all other conditions were favorable, we considered ourselves limited only by the tolerance of the skin and other normal tissues. The optimum dose usually meant maximum dose, unless the patient's general condition did not warrant it.

Two patients had received radiation treatment prior to admission to the University Hospitals. One woman with recurrent carcinoma had been diagnosed at operation four years before. She had been treated with intracavitary radium at that

\* Meigs' syndrome is the occurrence of pleural effusion and ascites in association with fibroma of the ovary. The reasons for fluid formation are not understood. It occurs promptly after tapping. Removal of the ovarian tumor effects a cure.

TABLE V  
TUMOR DOSE IN ROENTGENS

Less than 500	500-1000	1000-1500	1500-2000	2000-2500	2500-3000	3000-3500	3500-4000	4000-5000	5000-6000	6000 plus	Total
1	2	3	9	23	17	8	1	6	6	2	78

time and two years later she had had a carcinoma of the cervix for which she had been given three courses of roentgen treatment and additional radium therapy at another hospital. The other patient had been treated with radium for recurrent ovarian carcinoma a year before admission, which was five years after the original operation.

The tumor dose delivered to the ovary or its former location was calculated in 78 patients. They had been measured for anteroposterior and lateral dimensions at the time of treatment. In an effort to make the calculations as accurate as possible, measurements were taken with the treatment cone pressed against the patient, thus simulating the actual conditions under which treatment was given. Backscatter and depth dose figures were taken from the tables published by Quimby.<sup>12</sup> For the anterior and posterior fields, the mid anteroposterior diameter was taken as the location of the ovary. When lateral fields were used, a point 5 cm. lateral to the midline was taken as indicating the position of the ovary. When large anterior and posterior

fields were irradiated, the calculated tumor dose refers to the dose delivered throughout the pelvis but where lateral fields were used, the tumor dose refers to that delivered to each ovary or its former site. The dose which reached the contralateral ovary through the lateral fields was not included in our calculations.

The distribution of the tumor dose is shown in Table v. Of the 78 patients in whom the tumor dose could be calculated, only 6 received less than 1,500 r and 15 received less than 2,000 r. Forty patients received between 2,000 and 3,000 r, while the remaining 23 were given between 3,000 and 7,000 r. Most of these patients received two or three courses of treatment and the tumor dose is a summation of that given in all courses.

*Results.* Table vi indicates the length of survival of all patients. It is of interest to note that 48 patients died within three years following irradiation and, of these, 32 died within eighteen months. Only 9 patients died between three and five years after treatment while the remainder lived five years or longer. Thirty-three patients

TABLE VI  
SURVIVAL RATE

Group	0-6 mo.	6-12 mo.	1-2 yr.	2-3 yr.	3-4 yr.	4-5 yr.	5-6 yr.	6-7 yr.	7-8 yr.	8-9 yr.	9-10 yr.	10 yr. plus
I		1	3			1	4	2		4		6
II	11	3	5	5	5	1	6	2	2	1	3	4
III	1	1	4		1							1
IV	5	3	3	2		1		1				2
Unclassified Benign tumors and non-neoplastic disease	1							3				2
Total	18	8	15	7	6	3	10	8	2	5	3	15



are alive and apparently without disease. Twenty-eight of these had malignant neoplasms, 2 had benign neoplasms and 3 non-neoplastic diseases. Of the cases with malignant neoplasms, 61 (64.21 per cent) died of the disease, while 4 (4.21 per cent) died from other causes without evidence of residual or recurrent neoplasm. One patient (1.05 per cent) died postoperatively and another (1.05 per cent) died of diabetes insipidus one month after completion of treatment. If no cause of death was reported, we have assumed that the patient died of the disease.

TABLE VII  
FIVE YEAR SURVIVAL OF 95 PATIENTS WITH  
MALIGNANT NEOPLASM

		per cent
Alive without disease	28	29.47
Alive with disease	0	0
Died with disease	9	9.48
Died without disease	1	1.05
Total	38	40

The tabulations of the 95 cases with malignant neoplasm show that 38 (40 per cent) lived longer than five years (Table VII). Nine of these died with neoplasm after five years. One patient lived for fifteen years and died of what was thought to be recurrence; another patient died of massive abdominal recurrence ten years after irradiation (this was proved at autopsy) while a third patient died of an unknown cause eight and a half years after treatment. The remaining 6 patients died within five to seven years following roentgen therapy. One patient (1.05 per cent) died without evidence of neoplasm after nearly eleven years (this was proved at autopsy).

Ascites is usually considered a poor prognostic sign. It is of interest to note that 4 of the 25 cases in our series with ascites lived longer than five years. Two, classified in Group II, died sixty-six and sixty-seven months, respectively, following irradiation. The other 2 were classified in Group IV. Of these one is alive and the other died without evidence of neoplasm 135 months fol-

lowing irradiation (proved at autopsy as noted above).

#### DISCUSSION

The clinical diagnosis of malignant ovarian tumor is difficult, especially while the growth is still limited to the ovary. It is generally agreed, therefore, that the best treatment of these tumors is excision followed by irradiation if the tumor proves to be malignant.

At operation all visible neoplastic tissue, even in obviously incurable cases, should be removed. This reduces the amount of toxic material which will have to be absorbed following irradiation. Taylor<sup>15</sup> has found clinical evidence that small masses are handled more efficiently by roentgen therapy than are larger ones.

At the University Hospitals both fallopian tubes, ovaries and uterus are usually removed. Since we do not apply radium in cases of ovarian neoplasm, we believe it is not necessary to leave the uterus or cervix in place as a radium holder.

Postoperative irradiation is indicated in all cases with malignant ovarian tumors, even though the growth appears to have been encapsulated and removed in toto (Group I). It should be started as soon as the patient's condition permits. This is especially important in cases with ascites because rapid reaccumulation of fluid may be prevented. In cases classified in Groups II, III, and IV, irradiation is imperative. Although a few cases classified in these groups in the literature have lived five years or longer without recurrence, the chances of this are small. We advise against irradiation if multiple extra-abdominal metastases are present or if the patient is in poor general condition. However, we consider no tumor too extensive for irradiation if it is still confined to the abdomen and pelvis.

The many histopathologic types which differ widely in radiosensitivity and the development of certain complications make it extremely difficult to predict the future course of the disease. The degree of malignancy of the so-called special ovarian neo-

plasms is not definitely known. Disgerminomas most frequently show malignant tendencies while granulosa cell tumors and theca cell tumors show these tendencies less often. In cystadenocarcinoma, which is the most common type of malignant ovarian neoplasm, the capsule is gradually expanded until it ruptures. This results in implantations throughout the peritoneal cavity and the frequent production of ascites. Other malignant neoplasms, however, may also produce implantations through breaks in the capsule. In fact, we consider ascites as a direct indication of peritoneal implants or metastases, which may also not infrequently be produced through lymphatic spread. Bilateral occurrence of ovarian neoplasm is thought to result frequently from implantations or metastases from the primary ovarian neoplasm.

Since the onset of ovarian cancer is usually insidious, diagnosis is frequently not made until the tumor has progressed beyond the primary stage. This was true in at least 74 cases in our series (Groups II, III and IV), and this does not include several cases from which the surgeon had successfully removed all visible secondary neoplasm (classified in Group I).

If the patient's condition does not allow radical or even partial removal of the tumor, preoperative irradiation should be given. Occasionally this is followed by complete disappearance of the secondary masses. The primary tumor may also be considerably reduced in size but it is rarely sterilized. The residual neoplasm should be removed about six to eight weeks following irradiation. If ascites is present, less fluid is formed as the growth begins to regress under irradiation, and therefore paracentesis is needed less frequently. Often this is one of the first indications that the tumor is responding to the treatment (Healy<sup>4</sup>). If possible, however, biopsy or examination of the ascitic sediment should be attempted before irradiation. Of the 7 cases treated preoperatively, a diagnosis of malignant neoplasm had been made by this method in 3 cases; in 1 case no positive diagnosis

could be made although the ascitic sediment was examined repeatedly. The 3 remaining cases had non-neoplastic disease. They could have been spared the inconvenience of radiation treatment had they been operated on first.

Irradiation employed by different writers varied little in the physical factors: 165 to 200 kv. (peak), 0.5 to 2.0 mm. Cu, or their equivalents, and a focus-skin distance of 40 to 80 cm. were used most commonly. Usually the pelvis was irradiated through one large or two small anterior and posterior fields. Occasionally upper abdominal fields were added and one group was irradiated through gluteal and ischial fields as well. There was, however, considerable variation in the dosage and method of treatment. Wintz<sup>18</sup> believes that the full dose should be given within two or three days. During the past ten years, however, the majority of authors have treated their patients with fractional doses over periods varying from two to six weeks. The dosage given is usually stated in total roentgens (measured in air), roentgens (measured on the skin), or percentage of skin erythema dose. Jacobs and Stenstrom<sup>6</sup> believe a 50 to 140 per cent skin erythema dose is sufficient for each of several courses of treatment, while other authors<sup>3,4,7,17</sup> report doses (measured in air) of from 1,000 to 2,500 r to each field. Only three observers mention the dose delivered to the tumor site. With the concentrated method, Wintz<sup>18</sup> believes it unsafe to give more than 125 per cent skin erythema dose to the tumor. Healy<sup>4</sup> delivers about 2 threshold erythema doses throughout the abdomen and pelvis, and Montgomery and Farrell<sup>10</sup> consider a minimum of at least 1,600 to 2,000 r to the tumor an "adequate dose." We believe, however, that it is impossible to determine an "adequate" tumor dose in the treatment of ovarian tumors, as it is in nearly all malignant neoplasms. We could find no relationship between the number of roentgens delivered to the pelvis or ovarian site and the rate of survival.

As stated above we have been guided

mainly by the skin tolerance in prescribing the optimum dose. It is of the utmost importance, however, to judge each patient individually in outlining a course of irradiation, and this should be flexible enough to

As mentioned above, comparison of results reported in the literature is difficult and unsatisfactory since there is no uniform clinical and pathologic classification and the number of cases reported is usually

TABLE VIII

Author	Groups									
	I		II		III		IV		Total	
	Cases	Survival per cent	Cases	Survival per cent	Cases	Survival per cent	Cases	Survival per cent	Cases	Survival per cent
Wintz, 1932	4	75	44	25			3	33	51	29.7
Heyman, 1932	46	54	36	22	28	25	24	8.3	134	
Taylor, 1934	25		13		6		40		84	8
Montgomery and Farrell, 1934	4	75	2	100			5	0	11	45.4
Schroeder, 1934	27	60	9	25			20	9	56	32.1
Murphy, 1935									92	20.2
Harris and Payne, 1935	1	100	7	43			6	17	14	35.7
Jacobs and Stenstrom, 1937									31	35.4
May, 1939			16	55			35	23	51	31
Crainz and Schmiedemann, 1940	38	60.5	41	19.5			52	9.8	131	27.5
Meigs, 1940									64	12.3
Walters et al., 1941 I	5	20	3	0			7	0		
II	5	20							20	10
I	10	50								Inadequate treatment
II	5	20	11	22.2			5	20	31	29 Adequate treatment
Taylor and Greeley, 1942									26	34.6 Adequate treatment
									30	3.3 Inadequate treatment

allow for any change in the condition of the patient. Up to 1934, we gave most patients two or three smaller courses of irradiation at from three to five month intervals. From 1934 on, the procedure was changed and most patients received only one intensive course. The use of the Thoraues filter, the changing of the size of the irradiated fields and the addition of lateral fields allowed us to give larger amounts to the skin and also to reach a higher tumor dose.

small. Walter and his coworkers,<sup>17</sup> in reviewing the literature on patients treated by surgery alone, found that of 104 cases, which could be classified in our Group I, 48.5 per cent lived five years or longer. Only 6.4 per cent of the 94 cases corresponding to our Group II lived five years. No results were given for the inoperable cases but the rate of survival must be expected to be low. These authors also give their own results which are similar to those from the litera-

ture in Group I, but are 0 per cent for our Groups II and IV. The total survival rate was 6.7 per cent. Wintz<sup>18</sup> reports a survival rate of 10 per cent for his cases treated by surgery alone.

The consensus is that postoperative irradiation results in definite improvement of the five year survival rate. Crainz and Schmiemann<sup>1</sup> state that an increase of this rate from 0 to 20 per cent can be expected from postoperative irradiation of cases classified in our Group II. The total five year results reported by various authors during the past ten years are shown in Table VIII. They vary from 8 to 45.5 per cent, but the majority are between 25 and 35 per cent.

TABLE IX

Group	Cases	3 Year Survival	5 Year Survival
I	21	17 (81%)	16 (76.2%)
II	48	24 (50%)	18 (37.5%)
III	8	2 (25%)	1 (12.5%)
IV	17	4 (23.5%)	3 (17.6%)
Unclassified	1	0	0
Total	95	47 (49.4%)	38 (40%)

Most observers concur in their findings of a definite relationship between the clinical stage and the prognosis. Due to the varied number of cases reported, however, there is considerable discrepancy in the reported five year survival rate. The most consistent results are found in the cases classified in Group I—50 to 75 per cent of these lived five years or longer. These figures are comparable to, although slightly higher than, the results of surgical treatment alone for the same group. The reported results for the other groups, although not so consistent, show a definite improvement over those of surgical removal alone.

The results in our series of malignant neoplasms compare favorably with those cited above (Table IX).

#### SUMMARY AND CONCLUSIONS

(1) One hundred patients in whom a

diagnosis of ovarian tumor was made were given irradiation at the University Hospitals, Iowa City, Iowa, between 1930 and 1938. The neoplasms in 95 cases were malignant.

(2) The total five year survival rate of all cases was 43 per cent, that for the cases of malignant neoplasm was 40 per cent.

(3) Irradiation is indicated in all cases of malignant ovarian neoplasm, but this should be given after the removal of as much neoplastic tissue as possible. Pre-operative irradiation is indicated only in advanced inoperable cases. If possible, however, the pathologic diagnosis should be established first.

(4) Our results are in accord with those of most authors as reported in the recent literature. In comparison with surgical treatment alone, there appears to be slight improvement of the five year survival rate in Group I. There is, however, a marked improvement in Groups II, III and IV, which comprise over 75 per cent of all our ovarian neoplasms.

(5) It is our aim to give the maximum tumor dose. To achieve this, the skin tolerance dose was given through multiple fields about the pelvis and abdomen unless it was contraindicated by the patient's condition. We are not influenced by the clinical or pathologic classification.

(6) The majority of our cases received a tumor dose of more than 2,000 roentgens with no untoward consequences.

(7) We have found no relationship between the tumor dose and the rate of survival.

(8) This study again emphasizes the need of early recognition of ovarian cancer, since this will result in a greatly increased rate of survival.

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## DISCUSSION

DR. CHARLES L. MARTIN, Dallas, Texas. Drs. Kerr and Einstein have demonstrated the palliative effect of roentgen therapy on carcinoma of the ovary in a very convincing manner. My principal interest in their paper lies in their claim that complete cures have been produced in a few recurrent and inoperable cases. They report a series of 28 patients with proved cancer of the ovary alive and free of disease at the end of five years. The Group I cases were probably cured by surgery, but it is interesting to note that 11 of the salvaged cases fell in Group II, and that in 8 of them the tumor dose was only slightly more than 2,000 roentgens. I find it difficult to believe that peritoneal implants can be cured by this dosage, and hope the essayists will correct me if I have misquoted their figures.

Three of the successfully treated patients in Group II received two long series of roentgen treatments, with an average tumor dose of 4,400 roentgens, and 2 patients with inoperable recurrences did equally well with somewhat larger tumor doses, given in a similar manner. These findings seem to indicate that cancer of the ovary may actually be cured by a tumor dose of approximately 4,400 roentgens, given in two series. Certainly this is a worthwhile observation.

DR. EINSTEIN (closing). To answer the first question by Dr. Martin: We really cannot claim to have "cured" any of our patients with carcinoma of the ovary. We call it five year "survival." The exception might be one patient with papillary cystadenocarcinoma, classified in Group IV. As I have mentioned before, this patient lived for eleven years and at autopsy no evidence of neoplastic tissue was found.

The second question was about the number of cases with spill of malignant cells into the peritoneal cavity, classified in Group II. There were only 3 cases with spill and without evidence of secondary neoplasm and I have no figures on hand to say whether these were among the five year survivals.

His third question was in regard to the time interval between multiple courses of treatment in the cases living five years or longer. None were treated for recurrent carcinoma, and the time interval between the two and possibly three series of treatments was between three and five months.

# A ROENTGENOLOGICAL FILING SYSTEM ADAPTED FROM THE "STANDARD NOMENCLATURE OF DISEASE"

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NUMEROUS classifications, filing and coding systems have been devised to make useful roentgenological teaching material rapidly and easily available. The following article does not propound a new method but summarizes experiences at the Department of Radiology of the Oregon University Medical School in the use of an adaptation of the Standard Nomenclature of Disease<sup>3</sup> for coding and filing valuable roentgenograms over a period of two years.

## GENERAL REQUIREMENTS AND CONSIDERATIONS OF A FILING SYSTEM

The purpose of any cross filing or coding system is to place the numerous categories of disease into an orderly system suitable for indexing. This may be accomplished by using an alphabetical arrangement, a system of letters, a system of numerals or a combination of these.

In a medical school it is imperative that a comprehensive, flexible and practical system be used whereby examples from all categories of disease may be quickly and easily segregated and filed for teaching purposes.

In the organization of a cross filing system, the principal aim is simplicity and practicability. Individuals who come in contact with it must be able to grasp it readily and obtain the desired information quickly.

The average practitioner will have nothing to do with a system which appears complicated. For him an alphabetically arranged file would perhaps be better. On the other hand, it is difficult to list diseases in this way. Synonyms are numerous; the arrangement of words labile. The method requires infinite watchfulness in the segregation of the letters.

Simplicity is important where office help will do all clerical work. A uniform terminology of disease in conjunction with a practical manual is essential if the system is to function accurately.

A great difficulty in attaining these attributes lies in the fact that the body is not a simple structure and cannot be divided into simple systems. Its complexity requires considerable study before systems which are consistent, logically subdivided and distinctly separated can be defined. Most classifications are inadequate. The experience of one department is not that of another. Their systems, therefore, are not interchangeable. In spite of comprehensive study and painstaking preparation, consistent and persistent revisions and additions by one or several individuals must be made. It is admitted that the average individual is unable to cover the entire field of disease and anatomy in a systematic and logical way.

In the building of a system, the common diagnoses are quickly listed and the categories just as rapidly filled. Where variety is not so great the roentgenologist centers his interest on the occasional unusual finding. These are placed in their special pigeon-hole. Later, other cases belonging to an entirely different group are received and relegated to other divisions. Thus, peculiar and unusual findings begin to expand the file.

To be more specific, "Duodenal Ulcer" is soon filled with numerous clear cut entries. "Osteopetrosis" is referred to the secretary to be put under a new head as a prized example. "Diverticulum of the Stomach" finds its own particular space. Some years later after many more entries have been made, the need for an example of

"Marble Bones" for the next morning's rounds arises. Search is diligently made under this heading. The roentgenologist clearly remembers his having filed an example some time previously. "Osteopetrosis" is searched for, but no such heading can be found. "Unusual Bone Pathology" is next searched and re-searched without success. The following afternoon, after the meeting, the example will be found, accidentally, under "Osteoporosis"! The secretary at the time had been unable to recognize the word and not wishing to embarrass the doctor by asking him to decipher his own writing, had entered it under a heading which looked similar to a word she could recognize.

Walker<sup>2</sup> has succinctly summarized the history of a homemade system in these words: "If you arrange a classification for your department it will start out trim and simple. Then there will be additions. You become accustomed to its logical development. It is apt to wind up a hodge-podge of anatomic, etiologic, and technical terms."

It follows, therefore, that any system adopted requires some little study. But the system which requires the least amount of study and therefore allows for rapid receipt of information will be the most desirable.

In our department a revision of the existing system became imperative. The aforementioned failings were prominent. In looking for "Osteogenic Sarcoma of the Femur" there was as much chance to find the material under "Bone Tumors," "Unusual Tumors," "Sarcoma" or "Tumors of the Lower Extremity." With twenty entries, at least, in each category the amount of time needed to find the specific entity becomes apparent.

Several published classifications and codes<sup>3-5</sup> were examined and one chosen which was thought would fit our needs. A month's trial, however, revealed the need of new categories of disease and a reclassification of anatomical sites.

#### THE STANDARD NOMENCLATURE OF DISEASE

At this time our attention was called to the Standard Nomenclature of Disease<sup>6</sup> now published by the American Medical Association. We have taken this system in its entirety without changing one category and are using it as a radiological cross file. We are also using it to cross file our radiotherapy patients.

To date, the Nomenclature is probably the most comprehensive compilation of diseases ever coded. It is being revised constantly by authorities in their fields. The uniformity of its plan makes it an ideal basis for any medical coding system. It has received considerable recognition among hospitals, being used in many record rooms.

The system upon which it is based is well explained in the introduction to the Nomenclature. Two groups of figures designate the disease condition. The first group of three (or more) digits designates the site of the lesion; the second, separated from the first by a dash, the disease entity or etiological agent.

For example:

360-881.9	Secondary Squamous Cell Carcinoma of the Lung
i.e. 360-	Lung
-881.	Squamous Cell Carcinoma
.9	Secondary

This system has several prominent attributes.

*Simplicity.* The six or more figures in a row may look quite complex. Their division into topographical and etiological categories, however, is logical. In the final analysis it is simple. Each anatomical site has its three digits, the first identifying the anatomical system. It has been elaborately developed. As an example, 200- belongs to the musculo-skeletal system; 300- to the respiratory system, etc.

The etiological classification is similarly segregated, so that, -100 is designated as, Diseases Due to Lower Plant or Animal Parasites; -400, Diseases Due to Trauma or Physical Agents.



*Comprehensibility.* The Nomenclature embraces the entire medical field. It, therefore, must include all roentgenological diagnoses of disease. The plan is such that new diseases can always be added without disturbing the existing order.

*Flexibility.* The system may be as general or elaborate as necessary.

As an example, a "Simple Impacted Fracture of the Lateral Condyle of the Tibia" may be filed under any of the following code numbers:

- 200-416 Simple Fracture of Bone (Impacted, of Tibial Condyle)
- 237-416 Simple Fracture of Tibia (Impacted, of Lateral Condyle)
- 2371-416 Simple Fracture of Upper Extremity of Tibia (Impacted)
- 23714-416 Simple Fracture of Lateral Condyle of Tibia (Impacted)
- 23714-416.4 Simple Impacted Fracture of Lateral Condyle of Tibia

The parentheses indicate the detail not specified in the code.

In any event, if the simplest designation is too general it can be expanded, at no time requiring extensive revision of the various entries. In our file we would prefer the second example. If a more elaborate figure is chosen the place of the pathological entity is not greatly removed from its former place. It will be noted that all types of fractures will be found in the same immediate vicinity in the file.

#### THE SYSTEM IN PRACTICE

Our system is used to classify and arrange only those examples which are useful for teaching and research purposes. Patients of the hospitals and clinics associated with the Medical School receive a unit number which is used on all records, regardless of the number or time of visits. In keeping with this system, all of a patient's roentgenograms are kept in one envelope, identified by the unit number. A copy of all readings of the roentgenograms is typed on the exterior of the envelope. Since they form an integral part of the patient's history, interesting roentgenograms may not

be removed and kept in separate teaching or research files.

If, during the reading of roentgenograms a good example is encountered, a note is appended to the original requisition. This note contains the diagnosis and any other pertinent information which may be of value in discussing the roentgenogram at a later date. For example: "Normal Ventriculogram. Excellent filling of lateral and third ventricles. Stereoroentgenograms."

The secretary later adds the code number after reference to the manual, transfers it to an index card and includes the patient's name, unit number, code number, diagnosis and additional notes, the patient's age and date of the roentgenogram (Fig. 1).

Francistine, John	164962	920-000
Normal ventriculogram. Excellent filling of lateral and third ventricles. Stereoroentgenograms. Age 43. 9/6/43.		

FIG. 1

The terms used in the manual should be used consistently. The office clerks are then able to make their entries rapidly and easily. Synonyms tend to confuse and result in inaccurate entries.

The cards are placed in order in the file according to the diagnostic code. Suitable divisions are made in the file with different colored tabbed cards for convenience. Further instructions may be obtained from the Nomenclature (1942) pages xii to xv.

In addition, the original requisition is given to the librarian who makes a cross on the patient's envelope and adds the code number. This serves to prevent reduplication of entries.

New diagnoses are coded by the roentgenologist. A record of these is kept for later inclusion within the manual.

The diagnoses at times may be faulty. Additional information, however, is often obtained from ward rounds, staff members and the department of pathology. The unit number aids in locating the chart for still further study. Pertinent information received is added to the index card. In spite of faulty diagnoses the interesting roent-

genogram, at least, is not lost in a sea of routine roentgenograms.

#### THE MANUAL

The Nomenclature is a sizable volume containing a large number of diagnoses ap-

#### DISEASES OF THE GASTROINTESTINAL TRACT, GALLBLADDER AND BILE DUCTS

672- Anus	687- Gallbladder
661- Appendix	654- Ileum
652- Bile Ducts	653- Jejunum
662- Cecum	680- Liver
660- Colon	650- Small Intestine, generally
685- Common Bile Duct	640- Stomach
651- Duodenum	613- Teeth
657- Esophagus	
614-120.2 Abscess, alveolar	
661-120.2 Abscess, appendiceal	
639-100.2 Abscess, retropharyngeal	
613-011 Absence of unerupted teeth	
611-887 Adenocarcinoma of G-I tract	
611-887.0 Adenocarcinoma of G-I tract with metastases	
611-887.4 Adenocarcinoma of colon with obstruction	
611-013 Atresia of G-I tract	
640-940.9 Atrophic gastritis, chronic	
687-023 Calcification in walls of gallbladder	
687-041 Calculus in common duct	
611-852 Carcinoma of G-I tract, type undetermined	
611-851.4 Carcinoma of G-I tract, type undetermined, with obstruction	
647-881 Carcinoma of esophagus, squamous cell	
631-881 Carcinoma of hypopharynx, squamous cell	
641-881.9 Carcinoma, metastatic, squamous cell to stomach	
641-882 Cardiospasm, achalasia	
641-090 Cardiospasm, reflex	
600-410 Celiac disease	
637-013 Cholelithiasis	
652-012.0 Dilatation of common duct	
611-037 Displacement of G-I tract	
611-021 Displacement of G-I tract, congenital	
611-031.4 Displacement of G-I tract due to adhesions	
611-042 Diverticula of G-I tract	
637-039 Diverticula of esophagus, congenital	
637-040 Diverticula of esophagus, traction or pulsion	
611-042.1 Diverticula of G-I tract	
601-031 Duodenal ulcer	
601-031.3 Duodenal ulcer with perforation	
601-031.4 Duodenal ulcer with deformity	
601-032 Duodenitis	
601-033 Dyspepsia	

FIG. 2

plicable to the entire clinical field. For this reason it is too unwieldy and complex for the radiologist and the office clerks, who are interested only in the less numerous roentgen diagnoses.

A manual should be constructed, therefore, in which the diagnoses referring to roentgenological conditions are listed. Commonly used anatomical sites should be arranged alphabetically under the anatomical system, the whole forming a handy reference book.

The degree of precision with which a code number is determined would be illustrated in the manual by example. In referring to the foregoing example, a "Simple Impacted Fracture of the Lateral Condyle of the Tibia" would be listed in our file as 237-416 and not 23714-416.4. The latter would burden the file with an excessive number of currently unimportant subdivisions.

In our department the diagnostic codes were determined as the condition arose. After two years all diagnoses were tabulated. Excessively elaborate diagnoses were made more general. Old code numbers were critically examined, revised and unified.

All diagnoses under one system were arranged alphabetically beneath a short pertinent topographical classification (Fig. 2). The latter prevents unnecessary repetitions of diseases as demonstrated by the following example:

#### 611-642 Diverticula of G-I Tract

If the correct site happens to be the colon the necessary two figures can be obtained from the above topographical classification, i.e.:

#### 660-642 Diverticula of the Colon

#### DIFFICULTIES IN CODING

In building a manual, difficulties in coding become apparent. A diagnosis of "Duodenal Ulcer" is simple: its code number quickly determined from the Nomenclature. In the case of "Gastric Ulcer" a complication arises. It must be determined, to some extent, whether the common gastric ulcer or an ulcer the result of neoplasm is meant. If the latter can be demonstrated it should be listed as "Neoplasm of Stomach with Ulcer Formation."

The diagnosis of "Intestinal Obstruction" is not so simple from a coding point of view. It may be listed simply as:

650-610 Obstruction of Small Bowel Due to Unspecified Mechanical Abnormality.

If a more concise designation is required the following may be employed:

650-018 Intestinal Obstruction, Congenital, Due to Atresia

650-100.4 Intestinal Obstruction Due to Adhesions, Post-infectious

650-611.4 Intestinal Obstruction Due to Foreign Body

650-639.4 Intestinal Obstruction Due to Hernia

650-890.4 Intestinal Obstruction Due to Neoplasm, Type Undetermined

In all of the above cases 650- represents the small bowel only.

Whenever an attempt is made to become specific, it should be pursued consistently. Inevitably there arises an intestinal obstruction whose etiology is obscure or indeterminate. To the above list, then, must be added:

650-610 Intestinal Obstruction, Mechanical, Cause Unspecified

A similar condition arises in the classification of the arthritides. To group all arthritides having such widely variant etiologies as infectious, metabolic, neurogenic and unknown, under an all inclusive term would be impractical and illogical.

#### MANIFESTATIONS VS. DIAGNOSES

Very often the disease itself is not apparent from the roentgenogram. The manifestation, that is, the effect of the disease can be seen. Such appearances as "hydronephrosis," "hydrocephalus" and "mitral configuration of the heart" are not disease entities themselves but evidences of disease. No code numbers are listed under these headings and therefore some difficulty was encountered in transposing them. However, even if the disease entity is not evident, certain generalized facts can be used to

form a working code. The cause of a hydronephrosis is not always determinate but the code need only designate an accumulation of secretion in the pelvis due to mechanical abnormality, to be sufficiently exact.

Likewise, "hydrocephalus" not due to neoplasia or prenatal conditions was classified:

920-6x8 Accumulation of Secretion in Ventricles Due to Mechanical Abnormality

The code for "mitral heart configuration" was chosen as:

410-196.0 Rheumatic Heart Disease, Inactive

Although not necessarily correct, it is accurate enough for our purposes. At a future date it may be reclassified. It could be classified, also, under:

454-196.6 Rheumatic Valvulitis, Inactive, with Deformity of Mitral Valve

or,

417-196.6 Hypertrophy and Dilatation of Left Auricle Due to Rheumatic Fever

#### NORMAL STRUCTURES

In a teaching institution a large bulk of the reference file is composed of examples of the normal. The Nomenclature, chiefly interested in disease, has no designated code for the normal. The 1938 edition of the Nomenclature, with which the system was inaugurated, contained the entry:

y00-000 Disease, None. *Change First Digit to Indicate Suspected System, if Any.*

A similar entry is found on page 615 of the 1942 edition. This was used as a basis for the normal. A normal mandible would be designated:

219-000 Normal Mandible, or, a "congenitally non-pathological condition of the mandible."

However, this same figure is used to designate "Diseases Due to Abnormality of Bone Development, Generally and Unspecified" (page 61). Dr. Edwin P. Jordan,

editor of the Nomenclature, suggested, in a personal communication, the use of the etiologic digits -yoo, Disease Undiagnosed. The term might be confusing, implying the existence of a disorder which could not be proved from the roentgenograms. Apparently, some discrepancies exist which can be easily worked out.

#### CONCLUSIONS

We are advocating the use of an adaptation of the Standard Nomenclature of Disease for filing roentgenograms of interest. It would seem logical that a group of roentgenologists, well versed in the requirements of such a system should meet and direct the compilation of a comprehensive manual of roentgenological diagnoses. It would be well if this were published and made available to roentgenologists. Such a manual in conjunction with the Standard Nomenclature of Disease would then be a basis and an aid for the organization of their own indices and files.

#### SUMMARY

1. A comprehensive, practical, flexible and simple filing system for roentgenograms of unusual interest would fill a definite need. The ordinary attempts are a mixture of etiological, anatomical and technical terms.

2. Difficulties in building a file arise because of the complexity of human diseases and the inadequacy of simple descriptive terms.

3. The system in the Standard Nomenclature of Disease is practical and adaptable to many specialties. It divides the disease entity into an anatomical site and an etiological factor. The same system can be adapted to roentgenological diagnoses.

4. An adaptation of the Nomenclature which has been in use for two years is described.

5. A manual which included the majority of the more common roentgenological diagnoses was compiled from the Nomenclature.

6. Manifestations in contradistinction to diagnoses were coded under more general diagnoses.

7. Since the normal structures have no definite code numbers in the Nomenclature the use of -ooo and -yoo following the anatomical sites is suggested.

8. A manual of roentgenological diagnoses adapted from the Nomenclature and compiled by a competent group of radiologists would be of considerable value to roentgenologists of limited practice and of large departments in teaching institutions.

I wish to acknowledge gratefully the helpful suggestions made in the preparation of this manuscript by William Y. Burton, M.D., Assistant Professor of Radiology.

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# THE BEHAVIOR OF THIMBLE CHAMBERS WHEN USED FOR THE MEASUREMENT OF VERY SOFT RADIATION

By J. A. VICTOREEN, Z. J. ATLEE, and E. D. TROUT  
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THE purpose of this paper is to report an investigation of the behavior of a regular Victoreen thimble chamber at wavelengths that, until recently, were longer than the radiation available to the roentgen therapist.

The literature of the last few years includes several papers reporting the physical characteristics of this type of radiation.

mm. of aluminum, which is appreciably softer than that available from normal types of roentgen therapy tubes.

The chambers supplied with the Victoreen condenser r-meter have not been recommended for use in the measurement of radiation of longer wavelength than that produced by a Universal Coolidge tube operated without filter at 60 kv. Such radia-

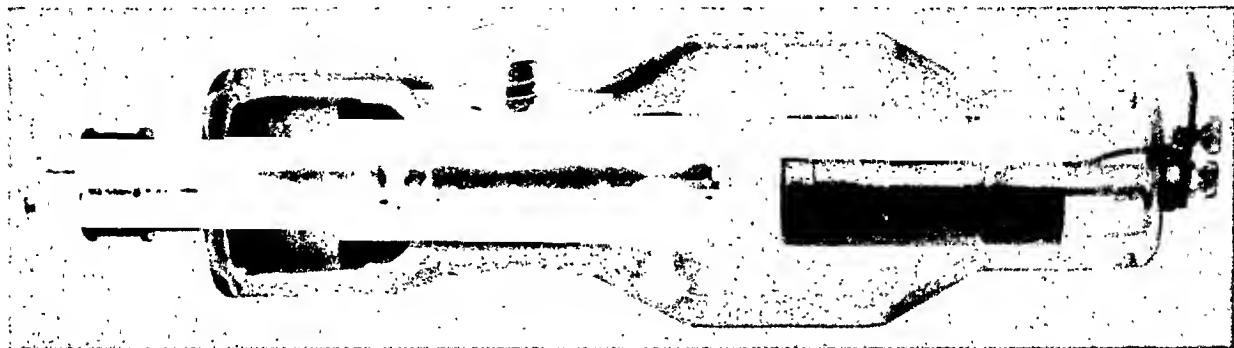


FIG. 1. Hooded anode roentgen tube with beryllium window.

These studies are reports on radiation produced by contact roentgen therapy equipment. Informative papers covering the subject have been provided by Braestrup and Blatz,<sup>1</sup> Lamerton,<sup>3</sup> and Quimby and Focht.<sup>4</sup> The latter described very thin experimental extrapolation chambers made entirely of lucite.

A review of the literature and a study of the equipment available for contact roentgen therapy indicates that there are in use two types of equipment producing radiation of quite different physical qualities.<sup>2</sup> One of these, the Chaoul type, operating at 60 kv. with no filter, produces radiation having a half-value layer of 3.3 mm. of aluminum, which certainly cannot be called soft radiation. The Philips type equipment operating at 44 kv. with no filter produces radiation having a half-value layer of 0.3

mm. of aluminum, which is approximately 0.4 to 0.5 angström effective wavelength. When used for the measurement of radiation of this quality a regular Victoreen thimble chamber will read low by approximately 5 per cent.

When a conventional (red) Victoreen thimble chamber with a bakelite wall is used for the measurement of the very soft radiation produced by the Philips type contact roentgen therapy unit, both practical and theoretical considerations point to the fact that it will give a reading considerably below the true intensity in roentgens.<sup>3</sup>

The major reason for an investigation of the behavior of thimble chambers at very long wavelengths is the possibility of roentgen therapy tubes having lower inherent filtration making available longer wave-

lengths for treatment. Such tubes have been produced experimentally<sup>5,6</sup> and they may become generally available after the war.

A tube having a beryllium window and characteristics permitting operation in air

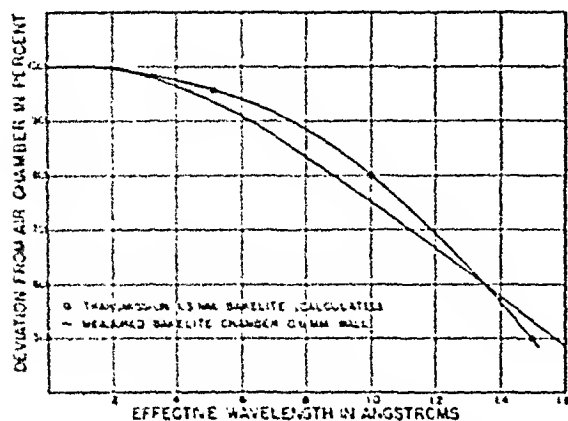


FIG. 2. Wavelength dependence of a regular Victoreen thimble chamber over a wide range of wavelengths.

at voltages from 10 to 160 kv. (peak) was constructed for these experiments. This tube was energized by a Villard type high voltage transformer.

An air chamber designed for very soft radiation was used for all the comparative measurements.

The quality of the radiation in all cases was measured as the effective wavelength. These determinations were made using a material thickness approximately equal to the half-value layer. Copper was used for these measurements up to an effective wavelength of about 0.3 Å, aluminum from 0.3 Å to approximately 1.0 Å, and beryllium for effective wavelengths longer than 1.0 Å.

The first data taken were for the purpose of plotting the wavelength dependence of a regular Victoreen thimble chamber at wavelengths up to 1.5 angstroms. The results are shown in Figure 2.

From this it will be seen that the Victoreen chamber will be down by about 40 per cent at an effective wavelength of 1.3 angstroms and about 50 per cent at an effective wavelength of 1.5 angstroms. This deviation from a standard air chamber is

largely due to absorption in the bakelite wall of the thimble chamber. It should be remembered that these data deal with very soft radiation. This is readily seen from the plotted data calculated<sup>7</sup> for monochromatic radiation through a flat bakelite sheet only 1.3 mm. thick.

To study the clinical significance of data taken at the very long wavelengths, additional studies were made at an effective wavelength of 1.5 angstroms.

From Figure 3 it will be seen that the regular Victoreen thimble chamber is not suited for use in measuring radiation of very long wavelengths. If the radiation therapist uses the intensity indicated by the thimble chamber, the patient will be given a greater dose in roentgens than was indicated by the measurements. The deviation from the true dose increases as the wavelength is increased beyond the range over which the regular Victoreen chamber is supposed to be used. Because of the wide variations in the electrical factors in use and the difficulty in obtaining accurate quality measurements outside the laboratory, it is not possible to set up a table of correction factors that might be useful within clinical limitations.

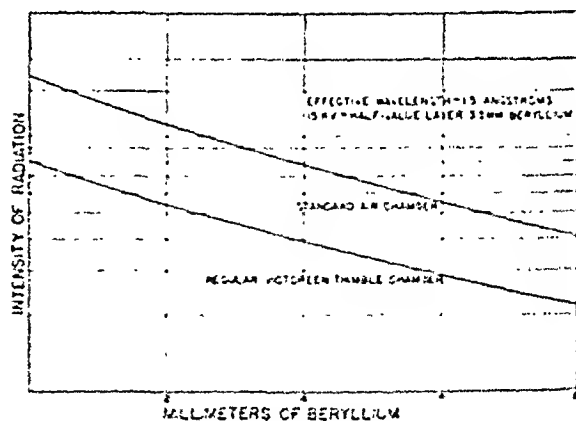


FIG. 3. Absorption curves in beryllium for effective wavelength of 1.5 angstroms.

When the regular Victoreen thimble chamber is used for the plotting of transmission data, at very long wavelengths the deviation from the air chamber is not great,

if the beam is fairly well filtered as it emerges from the tube. In Figure 4 the data used in plotting Figure 3 have been plotted, this time in the form of transmission curves. While transmission curves are of value in determining the quality of radiation, they cannot be used in establishing dosage values since the intensity is not stated in absolute values.

An attempt was made to design a thimble chamber that would coincide with the standard air chamber at very long wavelengths. A number of experiments were conducted in the limited time available. Up to the present, the most promising data have

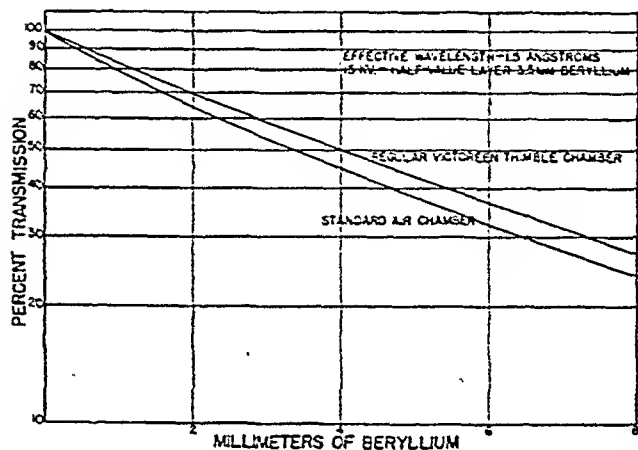


FIG. 4. Transmission curves in beryllium for effective wavelength of 1.5 angstroms.

been taken on a standardized thimble chamber with a beryllium wall. The wavelength characteristics for this chamber are shown in Figure 6.

This information on the beryllium chamber is not to be considered as final data on a chamber of this design. A further investigation of this problem is under way and will be the subject of an early report.

The authors are indebted to Mr. Robert E. Rinaaker for assistance in many of the necessary calculations.

#### SUMMARY

The trend toward lower inherent filtrations by the use of beryllium windows in roentgen tubes makes necessary the study of the behavior of thimble chambers for very soft radiations. The standard thimble

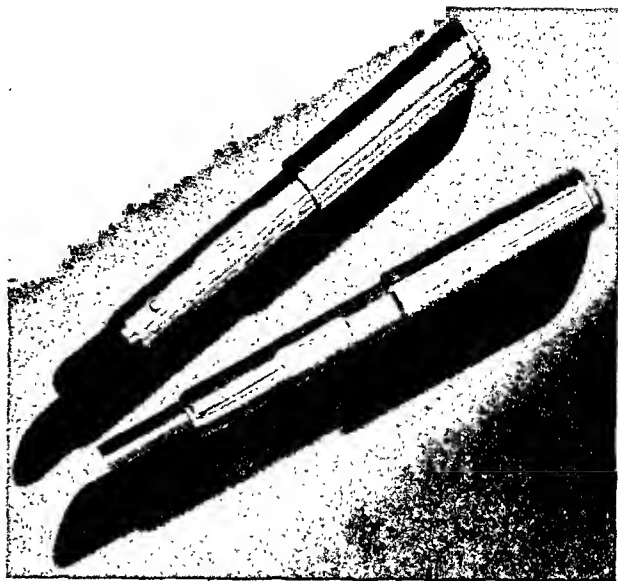


FIG. 5. Photograph of conventional Victoreen thimble chamber and experimental Victoreen chamber with beryllium wall.

chamber with red bakelite wall is not suited for measurement of wavelengths much longer than 0.5 angstrom effective, and at 1.5 angstroms it reads low by 50 per cent. An experimental beryllium wall thimble chamber is described with much less wavelength dependence, being only 10 per cent low at 1.5 angstroms by comparison with a standard air chamber.

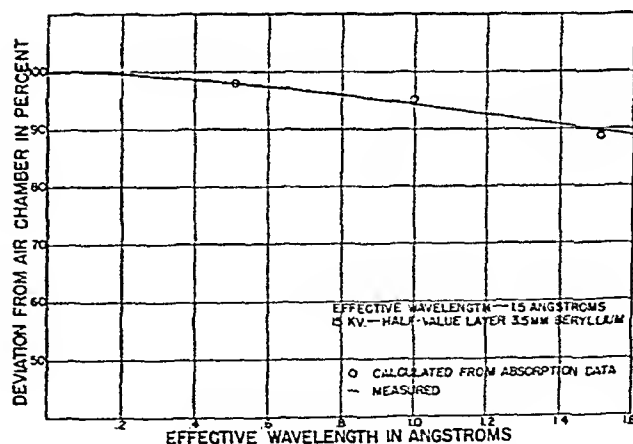


FIG. 6. Wavelength characteristics for an experimental Victoreen standardized thimble chamber with beryllium wall.

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# EDITORIAL

## HEMOPTYSIS IN MITRAL STENOSIS

**H**EMOPTYSIS is a not infrequent complication of rheumatic heart disease. This hemoptysis may accompany acute exertion, upper respiratory infection or it may occur during auricular fibrillation. Investigators on the subject of hemoptysis in rheumatic heart disease all agree that the intrapulmonary blood pressure is elevated. Many explanations have been advanced as a causative factor in the hemoptysis though a satisfactory one or at least one that would explain all the features of hemoptysis has not been found. Some investigators have thought that the hemoptysis is due to pulmonary congestion and hypertension which usually accompany mitral stenosis, causing rupture of the pulmonary blood vessels, or that there is an associated pulmonary arteriosclerosis which weakens the pulmonary vessels. Some think that the bleeding comes from sudden dilatation of the pulmonary capillaries, with diapedesis into the alveoli. However, none of the theories advanced for the cause of the bleeding has been entirely convincing.

Quite recently Ferguson and his collaborators<sup>1</sup> have described a method of injecting the bronchial veins, using a modification of the white lead solution which had been previously recommended by Schlesinger<sup>2</sup> for injecting the coronary vessels. These observers claim to have demonstrated a direct venous connection between the bronchial and pulmonary veins. From their injection methods of study they suggest that in mitral stenosis the veins in the submucosa of the larger bronchi dilate as a result of the collateral flow through

them, and that it is the rupture of these dilated veins that leads to hemoptysis.

That communications between the pulmonary veins and the bronchial veins exist has been formerly described and Miller<sup>3</sup> in a series of brilliant studies demonstrated these communications by injection experiments. Ferguson and his collaborators therefore decided to investigate these communications in cases of mitral stenosis in order to see whether submucous varices were present. Since the bronchial veins are difficult to locate and inject, they made their injections into the pulmonary veins with particulate matter too coarse to enter the capillaries. They used necropsy specimens from control cases having no clinical or pathological evidence of mitral stenosis. Six cases were of non-rheumatic heart failure, and eleven cases of mitral stenosis were investigated. All the lungs were from fresh autopsies. The injection mass was introduced into the pulmonary veins at a pressure of 80 mm. Hg. The solution was never seen in the pulmonary capillaries nor did it appear in the bronchial or pulmonary arteries, but in all the cases, including the controls, it was seen to pass freely from the pulmonary to the bronchial veins. In the cases of non-rheumatic heart failure three showed slight dilatation of the veins of the larger bronchi. Pulmonary arteriosclerosis did not affect the flow through the bronchial veins, nor was it affected by age or hypertension without heart failure. Six of the eleven cases of mitral stenosis that were injected showed definitely enlarged bronchial veins, and in four of these the venous dilata-

<sup>1</sup> Ferguson, R. C., K. A. R. R. T., and Deane, J. E. Venous communications between the bronchial and pulmonary veins in mitral stenosis. *Ann. Surg.*, 1944, 119, 407.

<sup>2</sup> Schlesinger, R. G. *Ann. Surg.*, 1934, 99, 100.

<sup>3</sup> Miller, W. S. *The Lung*. Charles C. Thomas, Springfield, Illinois, 1927.

<sup>4</sup> Hart, J. P. Mitral stenosis. *Lancet*, Jan. 27, 1906, 7, 112.

tion was pronounced. Four of these eleven cases had a history of hemoptysis and three of these showed pronounced dilatation. Hemoptysis was associated with pulmonary infarction in only one case: one of those in which dilated bronchial veins were demonstrated.

From their injection studies, Ferguson and his colleagues suggest that in mitral stenosis the flow to the left auricle through the pulmonary veins is hindered. As a result of the rise of pressure in these veins the venous anastomosis is reversed and blood passes from the pulmonary veins to the bronchial veins and thence to the right side of the heart. In order to meet this extra strain, the submucosal bronchial veins dilate and become varicose. In their opinion, hemoptysis is then due to rupture or ulceration of these veins, often precipitated by sudden alterations in pressure induced by a severe coughing bout, or by a sudden rise

in left auricular pressure such as may occur in auricular fibrillation.

In cases of mitral stenosis in which infarction and acute pulmonary edema are not present, the hemoptysis, so Ferguson and his collaborators believe, is probably due to bleeding from these dilated bronchial veins. While these ingenious injection studies may not explain the whole story, they do shed additional light on the causative factors of hemoptysis in mitral stenosis and their theory fits in fairly well with the current conceptions.

It is through such injection studies as these that many physiological and pathological processes are elucidated. The brilliant work of Batson in his injection studies of the paravertebral veins is a well known example of laboratory experiments explaining observed physiological and pathological processes.



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**AMERICAN COLLEGE OF RADIOLOGY**  
*Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago.*

**SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION**  
*Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: 1945, canceled.*

**ARKANSAS RADIOLOGICAL SOCIETY**  
*Secretary, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.*

**RADIOLOGICAL SOCIETY OF NORTH AMERICA**  
*Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meetings: 1945, to be announced.*

**RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY**  
*Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.*

**SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION**  
*Secretary, Dr. Earl R. Miller, University of California Hospital, San Francisco, Calif.*

**RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY**  
*Secretary, Dr. Max Climann, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.*

**SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY**  
*Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.*

**RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL ASSOCIATION**

*Secretary, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.*

**RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION**  
*Secretary, Dr. Roy G. Giles, Temple, Texas.*

**BROOKLYN ROENTGEN RAY SOCIETY**  
*Secretary, Dr. Leo Harrington, 885 Ocean Ave., Brooklyn, N. Y. Meets monthly on fourth Tuesday, October to April.*

**BUFFALO RADIOLOGICAL SOCIETY**  
*Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.*

**CHICAGO ROENTGEN SOCIETY**  
*Secretary, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.*

**CINCINNATI RADIOLOGICAL SOCIETY**  
*Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.*

**CLEVELAND RADIOLOGICAL SOCIETY**  
*Secretary, Dr. D. D. Brannan, 11311 Shaker Blvd., Cleveland 4, Ohio. Meets at 6:30 p.m. at Allerton Hotel and fourth Monday each month, October to April, inclusive.*

**DALLAS-FORT WORTH ROENTGEN STUDY CLUB**  
*Secretary, Dr. N. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meetings held in Dallas on odd months and in Fort Worth on even months, on third Monday, at 7:30 p.m.*

**DENVER RADIOLOGICAL CLUB**  
*Secretary, Dr. A. Page Jackson, Jr., 1911 Tremont Place, Denver, Colo. Meets third Friday of each month at Denver Athletic Club.*

**DETROIT ROENTGEN RAY AND RADIUM SOCIETY**  
*Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.*

**FLORIDA RADIOLOGICAL SOCIETY**  
*Acting Secretary, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Fla. Meetings in May and November.*

**GEORGIA RADIOLOGICAL SOCIETY**  
*Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.*

**RADIOLOGICAL SOCIETY OF KANSAS CITY**  
*Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month at a place designated by the president.*

**ILLINOIS RADIOLOGICAL SOCIETY**  
*Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.*

**INDIANA ROENTGEN SOCIETY**  
*Secretary, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meets annually second Sunday in May.*

**IOWA X-RAY CLUB**  
*Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.*

**KENTUCKY RADIOLOGICAL SOCIETY**  
*Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.*

**LONG ISLAND RADIOLOGICAL SOCIETY**  
*Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 p.m.*

**LOUISIANA RADIOLOGICAL SOCIETY**  
*Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.*

**MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS**  
*Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.*

**MILWAUKEE ROENTGEN RAY SOCIETY**  
*Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.*

**MINNESOTA RADIOLOGICAL SOCIETY**  
*Secretary, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.*

**NEBRASKA RADIOLOGICAL SOCIETY**  
*Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 p.m. at either Omaha or Lincoln.*

**NEW ENGLAND ROENTGEN RAY SOCIETY**  
*Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.*

**RADIOLOGICAL SOCIETY OF NEW JERSEY**  
*Secretary, Dr. H. R. Brindle, 501 Grand Ave., Asbury Pk. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.*

**NEW YORK ROENTGEN SOCIETY**  
*Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 3:30 p.m.*

**NORTH CAROLINA ROENTGEN RAY SOCIETY**  
*Secretary, Dr. Major Fleming, Rocky Mount, N. C. An-*

\* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

- nual meeting at time and place of State Medical Society.  
Mid-year scientific meeting at place designated.
- NORTH DAKOTA RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. L. A. Nash, St. John's Hospital, Fargo.  
Meetings held by announcement.
- CENTRAL NEW YORK ROENTGEN RAY SOCIETY**  
*Secretary*, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse.  
Three meetings a year. January, May, November.
- OHIO RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.
- PACIFIC ROENTGEN SOCIETY**  
*Secretary*, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.
- PENNSYLVANIA RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. L. E. Wurster, 416 Pine St., Williamsport.  
Next annual meeting, Hotel William Penn, Pittsburgh, May 5-6, 1945.
- PHILADELPHIA ROENTGEN RAY SOCIETY**  
*Secretary*, Dr. R. P. Barden, University Hospital, Meetings first Thursday of each month from October to May inclusive at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.
- PITTSBURGH ROENTGEN SOCIETY**  
*Secretary*, Dr. L. M. J. Freedman, 4800 Friendship Ave. Meets second Wednesday each month, 4:30 P.M., October to June, Pittsburgh Academy of Medicine.
- ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.**  
*Secretary*, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.
- ROCKY MOUNTAIN RADIOLOGICAL SOCIETY**  
*Secretary* Dr. A. M. Popma, 220 N. First St., Boise, Idaho.
- ST. LOUIS SOCIETY OF RADIOLOGISTS**  
*Secretary*, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.
- SAN DIEGO ROENTGEN SOCIETY**  
*Secretary*, Dr. Henry L. Jaffe, Naval Hospital, Balboa Park, San Diego, Calif. Meets monthly on first Wednesday at dinner.
- SAN FRANCISCO RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. Carlton L. Ould, University of California Hospital, San Francisco 22. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.
- SHREVEPORT RADIOLOGICAL CLUB**  
*Secretary*, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.
- SOUTH CAROLINA X-RAY SOCIETY**  
*Secretary*, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.
- TENNESSEE RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.
- TEXAS RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. Asa E. Seeds, Baylor Hospital, Dallas, Texas. Next annual meeting, Temple, Texas, Jan. 17, 1945.
- UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING**  
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.
- UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE**  
*Secretary*, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00-5:00 P.M., Room 301, Service Memorial Institute.
- VIRGINIA RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.
- WASHINGTON STATE RADIOLOGICAL SOCIETY**  
*Secretary*, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.
- X-RAY STUDY CLUB OF SAN FRANCISCO**  
*Secretary*, Dr. J. M. Robinson, University of California Hospital. Meets monthly, third Thursday evening.
- CUBA**  
**SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA**  
*President*, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.
- BRITISH EMPIRE**  
**BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY**  
Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.
- SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)**  
Meets on the third Friday of each month at 4:45 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.
- FACULTY OF RADIOLOGISTS**  
*Secretary*, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.
- SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS**  
*Secretary*, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.
- RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION**  
*Secretary*, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.
- CANADIAN ASSOCIATION OF RADIOLOGISTS**  
*Secretary*, Dr. J. W. McKay, 1620 Cedar Ave., Montreal, P. Q.
- SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION**  
*Secretary*, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.
- RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION**  
*Secretary*, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.
- SOUTH AMERICA**  
**SOCIEDAD ARGENTINA DE RADIOLOGIA**  
*Secretary*, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.
- SOCIEDAD PERUANA DE RADIOLOGIA**  
*Secretary*, Dr. Victor Giannoni, Apartado, 2306, Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión, Villalta, 218, Lima.
- CONTINENTAL EUROPE**  
**SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA**  
*Secretary*, Dr. J. Martin-Crespo, Fuencarral, 7, Madrid, Spain. Meets monthly in Madrid.
- SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)**  
*Secretary* for French language, Dr. A. Grosjean La Chaux de Fonds.  
*Secretary* for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.
- SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE**  
*Secretary*, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.
- ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD:**  
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.  
*Secretaries*, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.
- LENINGRAD ROENTGEN RAY SOCIETY**  
*Secretaries*, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.
- MOSCOW ROENTGEN RAY SOCIETY**  
*Secretaries*, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.
- SCANDINAVIAN ROENTGEN SOCIETIES**  
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

*To the Editor:*

It is with sincere pleasure that we have noticed and welcomed the regular attendances of an increasing number of U.S.A.M.C. roentgenologists at the scientific meetings of our three Radiological Societies—the British Institute of Radiology, the Faculty of Radiologists and the Section of Radiology of the Royal Society of Medicine.

Usually, the three Societies hold their meetings on the third Thursdays and Fridays in each month, in London.

We write as the Presidents of the three Societies to express the appreciation we have all felt of the interest shown and of the part played in discussion by our American radiological colleagues, and to say that their continued attendances will be warmly welcomed whilst they remain in Britain. Many of us wish that we could have offered more private hospitality, but this has been difficult to achieve because of the numerous war-time restrictions.

Our American visitors have undoubtedly helped towards the continued success of our meetings, which are by no means easy to arrange because of the extreme pressure of work on radiologists at the present time, and secondarily because of travelling difficulties.

We remain,  
Yours sincerely,

ROHAN WILLIAMS  
(British Institute of Radiology)

RAULSON PATERSON,  
(Faculty of Radiologists)

J. L. GROUT,  
(Section of Radiology, Royal  
Society of Medicine)

Full information may be obtained from the Secretaries at:

British Institute of Radiology,  
32, Welbeck Street, London, W.1.

Faculty of Radiologists,  
45, Lincoln's Inn Fields, London, W.C.2.

Section of Radiology,  
Royal Society of Medicine,  
1, Wimpole Street, London, W.1.

## SECOND INTER-AMERICAN CONGRESS OF RADIOLOGY

Preliminary announcement has been made of the Second Inter-American Congress of Radiology to be held in Habana, Cuba, January 19-24, 1946, under the presidency of Dr. Pedro L. Fariñas. The program of the Congress will include four official lectures, scientific sessions, and an extensive scientific exhibit. It is hoped that there will be a large North American delegation present at this Congress and that it may be truly representative of radiology in the Americas. Inquiries for further information should be addressed to the Secretary-General, Dr. R. Hernandez Beguerie, Calle 23 No. 411, Vedado, Habana, Cuba.

## CANCER TEACHING DAY

A Cancer Teaching Day presented under the auspices of the County of Erie Medical Society, Buffalo Academy of Medicine, Eighth District Branch of the Medical Society of the State of New York, University of Buffalo School of Medicine, Medical Society of the State of New York, and the New York State Department of Health, Division of Cancer Control, will be held in the Fillmore Room, Hotel Statler, Buffalo, New York, Thursday, April 26, 1945. The meeting will be called to order at 4 P.M. The following two papers will be presented at the afternoon meeting: "Diagnosis and Surgical Treatment of Carcinoma of the Breast," by Donald Guthrie, M.D., Robert Packer Hospital, Sayre, Pennsylvania; "What Can the General Practitioner Do about Lowering Cancer Mortality?" by Lloyd F. Craver, M.D., Memorial Hospital, New York. Dinner will be served at 6.30 P.M. at the Hotel Statler. The evening meeting will begin at 8 P.M. and the following papers will be given: "The Diagnosis and Curability of Intraoral Cancer," by Hayes Martin, M.D., Memorial Hospital, New York; "Carcinoma of the Colon," by John H. Garlock, M.D., Mt. Sinai Hospital, New York.



## AMERICAN RADIUM SOCIETY

The annual meeting of the American Radium Society which was planned for June, 1945, has been postponed indefinitely by decision of the Executive Committee. All officers, board representatives and committee members will continue to serve until a meeting of the Society can provide another election.

The following are the new members of the American Radium Society elected by the authority given to the Executive Committee:

H. Milton Berg, M.D., Bismarck, North Dakota

Daniel Catlin, M.D., New York, New York

L. K. Chont, M.D., Winfield, Kansas

George W. Chamberlin, M.D., West Reading, Pennsylvania

Frederick V. Emmert, M.D., St. Louis, Missouri

Gilbert W. Heublein, M.D., Hartford, Connecticut

Leonidas Marinelli, D.O., New York, New York

Alexander Ovalle, M.D., New York, New York

Lewis C. Scheffey, M.D., Philadelphia, Pennsylvania

Dominic J. Verda, M.D., St. Louis, Missouri

Palmer E. Wigby, M.D., Houston, Texas

## CLEVELAND RADIOLOGICAL SOCIETY

In commemoration of the semi-centennial anniversary of Roentgen's discovery of the x-ray, exhibits and lectures are being jointly planned by the Cleveland Radiological Society and the Museum of the Cleveland Medical Library. Dr. Otto Glasser, eminent Cleveland physicist and friend of Roentgen, is conducting the arrangements.

The following are the officers of the Cleveland Radiological Society: *President*, Dr. John O. Newton; *Vice-President*, Dr. J. Robert Andrews; *Secretary-Treasurer*, Dr. Don D. Brannan.

## DENVER RADIOLOGICAL CLUB

At a recent meeting of the Denver Radiological Club the following officers were elected for the coming year: *President*, Dr. George Unfug, Pueblo; *Vice-President*, Dr. John H. Jamison, Denver; *Treasurer*, Dr. Leonard G. Crosby, Denver; *Secretary*, Dr. A. Page Jackson, Jr., Denver.



## DEPARTMENT OF TECHNIQUE

*Department Editor:* ROBERT B. TAFT, M.D., B.S., M.A., 103 Rutledge Ave.  
Charleston, S. C.

### AN IMPROVEMENT IN DESIGN OF THE STEREO-SCOPIC PHOTOROENTGEN UNIT

By LIEUTENANT COLONEL ZOLTON T. WIRTSCHAFTER

*Medical Corps, Army of the United States*

THE necessity for a more rapid and efficient method of loading, unloading, and processing film for the photoroentgenoscope has arisen because of the tremendous number of permanent photoroentgen records required by the Armed Forces. The photoroentgenoscope records two 4 by 5 inch images stereoscopically on one 4 by 10 inch cut sheet of film. Sharpness and detail of the images recorded is equal to that obtained on the usual 14 by 17 inch films. The stereoscopic views clarify doubtful shadows and throw small shadows obscured by the ribs in one view into the rib interspace on the other view. Diagnostic accuracy as checked by many observers has been shown to be at least equivalent, if not superior, to that obtained on the 14 by 17 inch films. In surveys involving large numbers of chest examinations, the ease of operation, processing, and storage of the photoroentgenograms must also be considered. To decrease to a minimum the time consumed by the technical staff in loading and unloading film holders, and in processing large numbers of films manually, a roll film magazine was adapted to the photoroentgenoscope.

In the development of this adaptation, special attention was directed to availability of materials. It must be noted that this instrument was developed for the use of the Air Forces. In the experimental model of this device, a standard aerial camera was modified to replace the cut film holder supplied with the standard unit. The roll film

magazine of this camera is detachable and accommodates 56 feet of 5½ inch film at one loading. Due to the lack of sharpness and clarity experienced in using aerial photo films it was necessary to utilize standard single-coated roentgen film developed and recommended for use with the photoroentgenoscope. The camera is equipped with a motor-driven film transport which is actuated by a solenoid. Approximately 75 stereoscopic chest examinations can be recorded on one roll of film. The remote operation of the camera eliminates the need of a technician to reload the film plate holder after each examination.

The entire roll is developed in the Smith aerial roll film developing unit. This unit consists of three telescoping tanks for developer, rinse water and hyposolution. The film is loaded on a reel assembly which is then lowered into the tank of developer. A motor winds the film from one reel to the other, drawing the film through the developer. Upon completion of development, the entire assembly is lifted out of the developer tank and placed in the rinse water. The same procedure is followed for the fixing and the final washing operation. The roll is then dried on the Smith type aerial roll film dryer. Both the developing unit and the drying unit are standard Army Air Force equipment and are available at any base photo unit. Since the technique of developing roll film in this fashion has been developed by the Air Forces, no difficulty is foreseen in this procedure. The total time

necessary for the processing of a roll 56 feet long is one hour and fifteen minutes. This must be compared to the loading, unloading, and processing time for 75 sheets of 4 by 10 inch film. The roll may be stored intact, or it may be cut and each stereo pair filed with the individual's record.

centage of residual hypo than the ones processed in the conventional manner. This assures longer life and a more permanent record.

Although originally intended for use in the Army Air Forces, this equipment could be used by civilian agencies by establishing

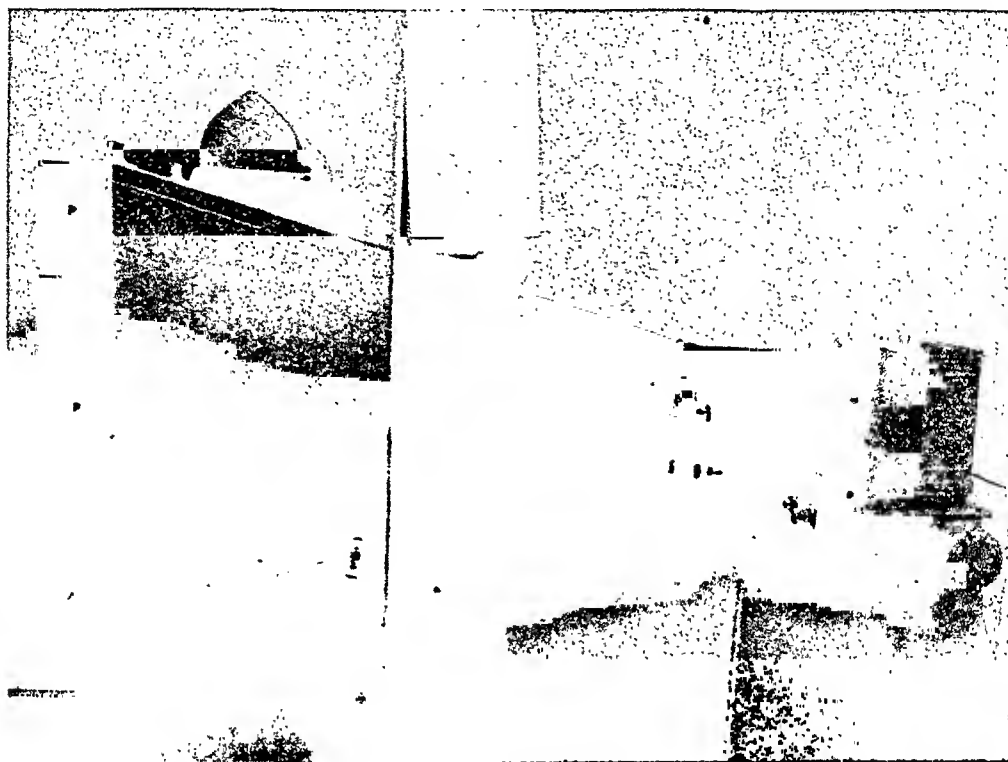


FIG. 1

The advantages of this modification are mainly concerned with the decrease in time of processing, the decrease in personnel, the saving of time in actual operation of the photoroentgen unit, and the elimination of large darkroom area allocated to drying facilities. In addition, it has been found that the photoroentgenograms processed in this manner actually have a smaller per-

a central film processing station. It has been suggested that this unit may find application in the field of inspection of small machine parts.

The author wishes to express his appreciation to the Photographic Engineering Branch of Technical Data Laboratory, and to the Photographic Laboratory, Materiel Command, Wright Field, for their excellent cooperation in the development of this apparatus.



# A PLASTIC ROENTGEN FILM EXPOSURE HOLDER

By MAURICE M. POMERANZ, M.D.  
NEW YORK, NEW YORK

THE Eastman folder for the use of non-screen film is a simple and useful device for its purpose. Its chief disadvantage, however, is that it soils quickly and bends or breaks at the corners, necessitating fre-

quent replacement. It occurred to me that a holder could be constructed of some plastic material which would eliminate these objections.

There are a number of inexpensive plastic materials on the market which can be utilized for this purpose. As an experiment I constructed three folders, one made of bakelite, a second of formica and a third of nitrate sheets. They all served their purpose well. To date, I have not found a sufficient difference in the absorption of these plastics to warrant any modification of technique.



FIG. 1

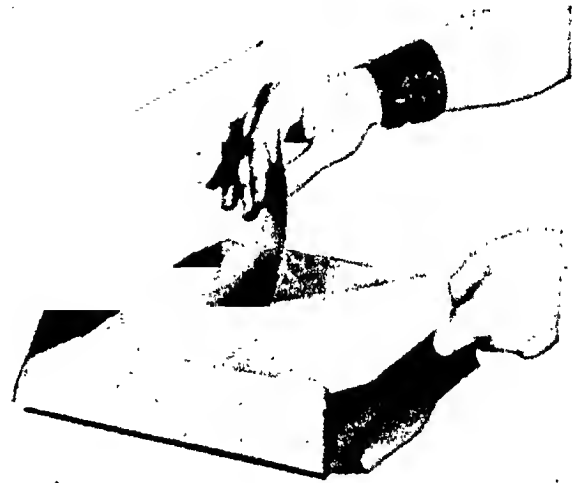


FIG. 3



FIG. 2

To construct the folders, two pieces of plastic material about  $\frac{1}{8}$  inch in thickness and measuring  $8\frac{1}{2}$  by  $10\frac{1}{2}$  inches are joined together at one end by adhesive tape which serves as a hinge. On one surface of the plastic sheet, lead foil is cemented or glued. This becomes the back of the holder. To it is next attached the red envelope which is part of the Eastman holder and into which the film is placed when ready for exposure. When attaching the envelope, it should be placed so that the large flap opens upward towards the front cover. Two metal clips or

fasteners are attached to the free end of the holder so that it is effectively sealed when the clips are turned back (Fig. 1, 2 and 3).

A new holder now being made will have two small metal hinges and an inside en-

velope which will be made of thin black linen.

1160 Park Ave.,  
New York 28, N. Y.



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## ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

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### ROENTGEN DIAGNOSIS

#### SKELETAL SYSTEM

BERKMAN, E. Etiological possibilities of march fractures. *J. Bone & Joint Surg.*, Jan., 1943, 25, 206-207.

In this paper, 15 cases of march fractures are discussed. They were proved by history, physical examination and repeated roentgenographic studies. The latter showed fourteen fractures involving the second and third metatarsals in the distal third. Ten were transverse; the fracture lines of the remaining four were never seen, but callus formation was noted approximately two weeks after injury. The fifteenth fracture, clearly seen, transverse in type, and involving the middle third, was in a patient forty-two years old. Thirteen fractures were in new recruits who had been inducted not over two weeks before. All 15 patients had been subjected to routine basic training and long hikes. Symptoms of all 15 patients appeared either during a march or ten to twenty-four hours afterward. Pain, lameness and swelling were the three major symptoms. Long hikes probably cause a severe foot fatigue in new recruits, while resistant Army shoes prevent a proper take-off, and produce excessive strain and stress over the metatarsal heads. Loss of the normal range of motion at the metatarsophalangeal joint, probably due to a tight capsule, predisposes to further loss of proper take-off and a resultant load on the metatarsal shafts. All 15 patients showed some loss of voluntary dorsiflexion.

Treatment consisted of using a cane, wearing Army shoes, and light massage and heat. The average stay in the hospital was five weeks. Later on, instructions were given to increase the range of motion of the toes, especially of plantar and dorsiflexion at the metatarsophalangeal joints. Proper shoe adjustments were instituted to correct the abnormal weight-bearing line. Approximately six weeks following diagnosis of march fracture, all 15 patients were doing full duty.—*R. S. Bromer.*

CAVE, EDWIN F. Calcification in the menisci. *J. Bone & Joint Surg.*, Jan., 1943, 25, 53-57.

Cave states the purpose of this paper is to point out the fact that calcified areas may occur in the menisci, and may be mistaken roentgenographically for osseous bodies arising from the synovia or articular cartilage, and lying free in the joint. He reports 2 cases with calcification in the menisci which he operated upon. Reference to the condition in the literature is rare.

The diagnosis of the condition can be made only by roentgenograms. The differential diagnosis is important, because, if the calcified shadow in the roentgenogram is thought to be within the meniscus, a useless search through the remaining portions of the joint can be avoided.

In each of Cave's patients, roentgenograms revealed a calcified shadow in the medial and posterior compartment. In the first case, this was reported as being consistent with a loose body in the knee joint. In the second case, the proper preoperative diagnosis was made, namely, injury to the posterior third of the meniscus with calcification. Both patients were relieved by the operation but Cave points out that symptoms in each were due more to the cartilage injury than to the calcified areas. Each patient presented symptoms and signs of internal derangement of the knee.—*R. S. Bromer.*

MILGRAM, J. E. Tangential osteochondral fracture of the patella. *J. Bone & Joint Surg.*, April, 1943, 25, 271-280.

Milgram reports 4 cases in order to describe the syndrome of osteochondral fracture of the patella, to urge its early recognition, and to differentiate it clinically and pathologically from the degenerative type of osteochondritis dissecans of the patella, which also results in the formation of free bodies in the knee joint.

The history is usually that of a child or young adult who twists the knee, usually in the extended position. A loud noise, sudden pain and occasionally a distinct dislocation of the patella laterally ensue. The knee fills with blood. Disability is usually complete. When, in the course



of one to three weeks, the swelling begins to subside, and motion is recommended, a free body is found to exist within the joint. If operation is performed early, it will be found that a previously quite normal patella has experienced a purely traumatic avulsion of the cartilage of (usually) its medial inferior quadrant. If operation is not performed early, recurrent episodes of impingement of the free body will eventually necessitate operation. In this late period of the condition, the free body will be indistinguishable from that of an idiopathic degenerative osteochondritis dissecans.

Milgram suggests that the mechanism is one of tangential direction of the stresses involved. The patella momentarily rubs tightly sideways over the outer condyle with sufficient force to score the cartilage of the patella and femur and leave "glacial grooves" on the patella. Occasionally, probably more often than can be demonstrated, a true dislocation occurs. Then the medial border of the patella catches against the prominent edge of the femoral condyle. As the quadriceps pulls the patella back into line, a chondro-osteal layer is ripped off and left behind and the condylar synovial membrane locally is markedly traumatized.

The treatment recommended is prompt operative removal of the free body. As the walls of the patellar defect were rather perpendicular, Milgram thought it advisable to shave the peripheral edges of the defect down to a moderate obliquity. In his cases, free body formation after operation has not thus far occurred.—*R. S. Bromer.*

GROAMLEY, RALPH K., and DOCKERTY, MALCOLM B. Cystic myxomatous tumors about the knee. *J. Bone & Joint Surg.*, April, 1943, 25, 326-338.

The authors report 4 cases of unusual mucinous tumors of the knee joint. Two were probably cysts of the meniscus, one having an unusual amount of bone change, one other was probably an unusually extensive development of a parameniscal cyst, and the fourth was a true myxomatous tumor of the meniscus. They suggest that cysts of the meniscus apparently are not true neoplasms, but that they represent the end-results of degeneration. Such cysts may sometimes be distinguished from other cysts in the region of the knee joint by the absence of endochondral ossification.

The roentgenographic examination in the

second case of their series showed swelling of the soft parts about the lateral side of the knee joint. In the fourth case, extensive hypertrophic changes were shown in the roentgenogram about the medial portion of the tuberosity of the tibia.—*R. S. Bromer.*

HUTCHISON, ROBERT G. Osteochondritis dissecans; records of some unusual cases. *Brit. J. Radiol.*, May, 1943, 16, 147-149.

Osteochondritis dissecans usually occurs at the knee joint and most frequently in the internal condyle of the femur. Seven cases are described and illustrated with roentgenograms in which the site of the process was unusual. In 3 cases the lesion was in the knee joint but at an unusual location, 2 cases in the lateral femoral condyle and in the third in the patella. In 2 of the other cases the lesion was in the ankle, in 1 in the base of the proximal phalanx of the right great toe and in 1 in the head of the third metacarpal bone.—*Audrey G. Morgan.*

BRILLSFORD, JAMES F. Osteogenesis imperfecta. *Brit. J. Radiol.*, May, 1943, 16, 129-136.

Osteogenesis imperfecta is characterized by imperfect ossification and abnormal fragility of the bones of the fetal skeleton. It is familial and associated with blue sclerotics and often with deafness. These cases can be followed up by roentgenography and the changes that take place through the years noted. Nine cases are described and illustrated with roentgenograms.

In the fetal type, ossification does not proceed beyond calcification of the cartilage; the bone therefore cannot withstand the crushing effect of labor and multiple fractures occur. If the infant survives, the bones show lack of density due to insufficient calcium. The ends of the long bones are expanded and there is some flattening of the curvature of the ribs and bowing of the long bones of the lower limbs. Ossification of the upper limbs takes place at almost a normal rate. As puberty approaches the borders of the metaphyses become irregular; multiple rounded islands of non-ossified tissue may be seen in the metaphyses and ends of the diaphyses. The measurements of the ends of the bones are normal but they appear enlarged because the shafts are so slender; they seem to be solid rods of compact tissue with little or no marrow. In some cases the lower limbs have become so deformed that amputation was necessary. The skull bones are thin and the skull is ballooned.

In cases associated with scurvy subperiosteal hematomas occur. One of the cases described was of this type.—*Audrey G. Morgan.*

PHALEN, GEORGE S., and GHORMLEY, RALPH K. Osteopathia condensans disseminata associated with coarctation of the aorta. *J. Bone & Joint Surg.*, July, 1943, 25, 693-700.

A case of osteopathia condensans disseminata is reported which had some of the characteristics of three types of sclerosing osteopathy—osteopoikilosis, osteopetrosis, and melorheostosis—and in which the patient also had an associated coarctation of the aorta.

Roentgenograms of the skull of the patient were reported negative. Those of the chest showed a notching of the ribs diagnostic of coarctation of the aorta. Of the other bones, the left innominate, left femur, left tibia, left fibula, all the bones of the left foot, the right scapula, right humerus, and right carpal bones were revealed as the sites of disseminated regions of bone sclerosis. There was discrete mottling throughout the bones in the carpus and tarsus and in the region of the epiphyses and metaphyses of the left femur, tibia and fibula, and the right humerus. The coracoid process, the neck and the body of the scapula, and the entire left innominate bone revealed similar spotting together with a more diffuse sclerosing process. The diaphyses of the left femur, tibia and fibula however, showed a remarkable generalized sclerosis with marked thickening of the cortices.

The case thus presented the disseminated spherical and elongated regions of increased density in the bones which characterizes osteopoikilosis. Linear striae or streaks of condensation along the shafts of the bones which have been described as occurring in osteopathia condensans disseminata were also present in the patient. The remarkable thickening of the cortices of the right femur and tibia were, however, more characteristic of melorheostosis or of osteopetrosis. The extreme density of the phalanges was more suggestive of osteopetrosis. To the authors' knowledge no exactly comparable case to this one has been described in the literature.

After discussing the possible causation of these diseases, the authors agree with others that all sclerosing osteopathies are probably due to some defect of genetic arrangement with some faulty differentiation and growth of bone from mesenchyme.—*R. S. Bromer.*

HERMON, R. Two cases of osteochondral hypothyroidism. *Brit. J. Radiol.*, July, 1943, 16, 208-211.

It has long been known that disturbances in the ossification of the epiphyses occurred in cretins but there may be bone changes that can be demonstrated roentgenologically in lesser degrees of hypothyroidism. Two such cases are described and illustrated with roentgenograms—one in a boy of nine and the other in a girl of four.

Schaefer and Purcell say that so-called juvenile chondro-epiphysitis is not caused by vascular changes or inflammation but by hypothyroidism. They suggest that the confusing terminology of these different diseases should be given up and they should all be called osteochondral hypothyroidism.

It is important to differentiate these cases from Perthes' disease as the latter does not yield to thyroid treatment but prolonged immobilization is necessary in order to prevent deformity. In osteochondral hypothyroidism retardation of bone development is the rule. The appearance of the epiphyses varies from a slight granular lack of homogeneity to a coarse or fine stippling or fragmentation. This fragmentation, however, is only apparent while that of Perthes' disease is a true fragmentation. In addition to the apparent fragmentation in osteochondral hypothyroidism, there is a line of cleavage in the capital femoral epiphyses dividing the epiphysis into inner and outer halves. This is probably due to splitting of the relatively brittle bony epiphysis by pressure. There is a greater tendency to this pressure splitting in osteochondral hypothyroidism than in Perthes' disease, and it may lead to extreme deformity. The epiphysis generally does not show the degree of flattening seen in untreated cases of Perthes' disease.

The importance of routine roentgen examination of the skeleton in suspected cases of endocrine disturbance in young patients is emphasized.—*Audrey G. Morgan.*

RUSO, PETER E. Chondro-osteodystrophy: Morquio's disease: case observed during pregnancy. *Radiology*, July, 1943, 41, 42-47.

A case of Morquio's disease is reported in a colored female dwarf twenty-six years of age. She was in the seventh month of pregnancy and came for treatment for severe dyspnea, which was attributed to the pregnancy. Her body was

36 inches long and she weighed 58 pounds. Both Wassermann and Kahn tests for syphilis were positive. At the end of the eighth month of pregnancy the dyspnea was so alarming that she was delivered by caesarean section. She made an uneventful recovery but the child died ten hours after delivery. The child's skeleton showed no abnormalities but that of the mother during life had shown the typical changes of Morquio's disease. All the bones appeared decalcified. Bone trabeculations were poorly developed and thickened. Various degrees of arrest of bone development had occurred.

This disease was first reported by Morquio in 1929 and up to date about 35 or 40 cases have been recorded. So little is known of the underlying cause of the disease that it is known by various names. Morquio believed the disease to be hereditary and believed that consanguinity and hypocalcemia played an important part in it. Most of the cases so far reported seem to follow the mendelian law. These patients are dwarfs.

The roentgenogram shows shortening and distortion of practically every bone of the skeleton. The epiphyses do not ossify and there is delayed ossification and non-fusion of secondary centers of ossification. All joint spaces are widened and the joint surfaces irregular and eroded. The bodies of the vertebrae are narrowed and flattened. All the bones are decalcified and the changes are symmetrical.

In the early stages of the disease treatment is frequently given for rickets. All forms of treatment tried have proved unsuccessful.—*Audrey G. Morgan.*

HILLIARD, CEDRIC. A case of chondro-osseous dystrophy with punctate epiphyseal dysplasia. *Brit. J. Radiol.*, May, 1943, 16, 144.

A child born June 22, 1922, was cyanotic at birth, suggesting a congenital heart lesion. The upper arms were short and the fingers in flexion. The legs were flexed and could not be straightened. The birth weight was 5½ pounds and there was no gain during the first month. Roentgen examination about three weeks after birth showed the skull large and globular with the bridge of the nose sunken. The vertebrae were deformed and irregularly developed. The upper arm was short with a large spade-like hand with flexed fingers. The joints of the limbs showed cuppling due to alternating areas of increased and decreased density. The areas of decreased

density appeared to be composed of osteoid tissue rather than true bone.

A number of other cases of dwarfism with abnormalities of bone structure are reviewed briefly. All these are cases of a fundamental deficiency of cartilage; the most extreme form of this defect is achondroplasia and the mildest, congenital dislocation of the hip which seems to be due to a change in the form of the epiphysis as a result of mucoid degeneration of the cartilage.—*Audrey G. Morgan.*

HERZMARK, MAURICE H. Herniation of the cauda equina following laminectomy of the sacrum. *J. Bone & Joint Surg.*, Jan., 1943, 25, 197-201.

A case of herniation of the cauda equina through a defect in the sacrum, made to remove lipoidol, is reported. The author emphasizes the need of caution in opening the spinal canal. Some have advocated hemilaminectomy or other osteoplastic operations to overcome this possible complication. Herzmark concludes that defects in the spinal canal are better protected if bone chips are laid across them before closing the soft tissues.

In the case reported, the cord was found protruding from the canal in a loop-shaped segment, caught by a band of fibrous tissue above and compressed against the sharp thin ledge of bone which formed the lower boundary of the defect made in the sacral canal at the time of the removal of the lipoidol. The gap in the neural canal was covered by taking thin, flat pieces of bone from the sacrum, and placing them across the canal like tiles, until the cauda equina and its canal was completely roofed. The patient made a very satisfactory recovery.—*R. S. Bromer.*

OPPENHEIMER, ALBERT. Paravertebral abscesses associated with Strumpell-Marie disease. *J. Bone & Joint Surg.*, Jan., 1943, 25, 59-56.

Oppenheimer could find no references in the literature to Strumpell-Marie disease associated with paravertebral abscesses and he found it difficult to understand why these two distinct conditions were associated. He had 4 cases and some findings were common to all of them. In each the disease was chronic and began with pain and stiffness in some part of the back or neck. In the course of several years, the pain tended to subside and the stiffness in-

creased but the symptoms remained confined to the region originally affected. Abscesses in the soft tissues of the back or neck were present at the level, but not below, the involved vertebrae. Roentgenograms showed an ankylosing arthritis of the apophyseal joints at the level of the soft tissue abscess, with ossification of the vertebral ligaments, but without destruction of bone which might account for the abscesses.

In the 4 cases, roentgenographic examinations failed to reveal signs of bone destruction and repair. In speculating on the association of these two conditions, Oppenheimer could think of only two pathological processes which could account for the lesions observed in his patients. He thought it possible that the lesions were caused by a hitherto unknown type of necrosing bone infection. Since no evidence of necrosis could be found, he considered the vertebral origin of the abscesses as doubtful. Since this was the case, he thought the possibility of the abscesses being the cause rather than the result of the apophyseal arthritis should be considered. He believes the possibility cannot be entirely discarded that the apophyseal arthritis was the result of the persistent hyperemia which accompanied the chronic purulent infection of the paravertebral soft tissues. As in other cases of rheumatoid spondylarthritis, the ossification of vertebral ligaments which was present in his cases was a secondary phenomenon.—*R. S. Bromer.*

PERLMAN, ROBERT, and FREIBERG, JOSEPH A.

The bridging of the vertebral bodies in tuberculosis of the spine. *J. Bone & Joint Surg.*, April, 1943, 25, 340-350.

The findings in the active stage of tuberculosis of the spine are well known, namely, bone destruction, osteoporosis, and abscess formation. Healing takes place by fibrosis, organization of abscesses, resorption of sequestra, osteogenesis, and at times bony fusion between the involved vertebrae. This healing is seen in the roentgenogram as sclerosis of bone, sharper delineation of the bones, and decrease in the size of the abscesses. The phenomenon of bridging of the vertebral bodies at the site of the tuberculous bone involvement is not widely known. This bridging in tuberculous spondylitis may be overlooked and has come to be associated rather with pyogenic infection of the vertebrae.

Five cases are reported, 4 showing osseous

bridging of the vertebral bodies and the fifth, abortive bony bridging which could not be considered to be actual spontaneous fusion. They regard the process as a reaction to irritation with periosteal new-bone formation or ossification in ligamentous tissue and not as evidence of a healing process. In certain instances such bony bridging accomplishes fusion of the vertebrae involved by tuberculosis as effectively as posterior surgical fusion.—*R. S. Bromer.*

HALBERSTAEDTER, MAX. Familial vertebral dystrophy. Case reports. *Brit. J. Radiol.*, April, 1943, 16, 121-124.

Cases of vertebral dystrophy are described in two brothers aged thirty-nine and thirty-five. The parents and a brother and sister are normal. The first patient came for treatment on account of pain in his left hip which was shown to be due to osteoarthritic changes. Examination of the other members of the family followed. The vertebrae are flattened and elongated in the anteroposterior direction. The upper and lower edges of the vertebrae are ill-defined and uneven and the intervertebral spaces are a little decreased. Some of the nuclei pulposi show calcareous degeneration. There is notching just behind the anterior edge in the lateral view. The flattening and elongation of the vertebral bodies is less marked in the lumbar than in the dorsal spine. In both cases there is straightening out of the dorsolumbar curve. In the younger brother the second phalanges are shortened. The pelves are smaller than normal in both cases.

The familial incidence and widespread changes in the spine, together with the changes in the pelvis and hands, indicate that these are cases of familial osteodystrophy. The type of dwarfism, due to shortening of the spine, is quite different from that seen in achondroplasia. Brailsford has described four types of chondro-osteo-dystrophy, and these cases, from the type and pattern of the lesion, the pelvic changes, the slight peripheral changes and the familial incidence, seem to belong in his class C.—*Audrey G. Morgan.*

HYNDMAN, OLAN R., STEINDLER, ARTHUR, and WOLKIN, JULIUS. Herniated intervertebral disk; a study of the iodized oil column. *J. Am. M. Ass.*, Feb. 6, 1943, 121, 390-401.

Herniated intervertebral disk, or herniation of the nucleus pulposus is clearly a causal factor

for low back pain associated with radiating pain in the sciatic distribution. Herniated disk provokes a syndrome of spinal nerve root compression, and the radiating pain is referred pain associated with the signs and symptoms that attend direct root involvement. A syndrome due to myofascial trauma is associated with or provokes a strictly reflex sciatic radiation and hence can be differentiated from referred sciatic radiation. In this paper the authors report on 63 laminectomies with reference chiefly to a method of differential diagnosis and to the interpretation of the iodized oil column. Herniated disks were found in 50 cases. The disk was below the fourth or fifth lumbar vertebra in 46 cases (92 per cent). It was below the seventh cervical in 1 case, below the ninth dorsal in 1 case and below the third lumbar in 2 cases.

All 46 patients with herniated disks at the fourth or fifth lumbar described radiating pain down the posterior aspect of the thigh and at least to and involving the leg—usually the lateral aspect or calf of the leg. Thirteen of these patients said there was no pain in the foot. Thirty-three described pain radiating to the foot—usually the ankle, dorsum or ball of the foot. Coughing and sneezing exaggerated the pain in the back and down the leg in 39 cases.

Signs included spasm of the erector spinae muscles with a list favoring the pathologic side, pain and limitation on bending forward as in touching the floor, reproduction of the radiating pain by forcefully pressing in the paravertebral space between the iliac crest and the lumbar spine with the thumb and on the pathologic side and tenderness along the course of the sciatic nerve and of the calf muscles. Kernig's sign or the straight leg raising test was positive in all cases.

The iodized oil column is characterized at least by pairs of axillary pouches which mark the points at which nerves leave the dural canal. The axillary pouch is the landmark for herniated disk. In all of the cases in this series if the disk caused a notch in the lipiodol column, the notch included the axillary pouch. If a filling defect occurred between two pairs of axillary pouches and did not include either, it was not due to a herniated disk. In analyzing the iodized oil film, the defects are classed according to the following types: 1. Complete, in which a filling defect extends completely across the iodized oil column. 2. Definite unilateral defect, in which a definite notch is cut out of the

iodized oil column on one side. 3. Definite bilateral defect in which a definite notch is cut out of the iodized oil column on both sides at the same segment. 4. Mild defect, in which there is a mild filling defect at an axillary pouch. 5. Root sign, in which there is no filling defect in the iodized oil column proper but there is some displacement of the root from its normal course or a blunt cessation of the passage of iodized oil down the root sheath.

The phenomenon of referred sciatic pain is most strikingly represented in the clinical syndrome of the herniated intervertebral disk. Sciatic pain due to pressure of the disk on the sensory spinal root is of mechanistic origin. There is, however, another possible source of the pain phenomenon, namely that it is of reflex origin. By this is meant that the pain impulse travels from a peripheral point, in this case the strained soft structures of the back, centripetally to the spinal cord, and makes then synaptic contact with other sensory units at different levels and with different anatomic distribution, with the result that pain sensation is recorded in the territory of the second unit.

The reflex character of such a sciatic pain can be proved only if the reflex arc can be interrupted at the point of the primary local irritation, in this case the soft tissue lesion in the back, and if such an interruption immediately and absolutely abolishes the radiation along the sciatic nerve. In the case of the low back pain this is facilitated by the fact that many patients show so-called trigger points; that is, small, strictly localized and distinctive areas of pain on pressure. These are most frequently the lumbosacral junction, the posterior superior iliac spine, the gluteal insertion at the outer posterior rim of the ilium and the posterior border of the tensor fasciae. For the past five years the authors have been able to prove that some sciatic radiations associated with low back pain are of this purely reflex character. This proof is furnished by producing or intensifying sciatic radiation by simple stimulation of the circumscribed painful area in the back; furthermore, by the fact that infiltration with 5 to 10 cc. of a 1 per cent solution of procaine hydrochloride into this area at once abolishes the sciatic radiation.

In a small percentage of patients who present definite symptoms and signs of root compression, including an absent achilles tendon reflex, no herniated disk, concealed or otherwise, is found. In this type of patient complete removal

of the fourth and fifth lumbar laminal arches and their accompanying ligamenta flava and partial unroofing of the intervertebral canals of the fifth lumbar and first sacral roots are advisable. The results in this type of patient following such a decompression have been very encouraging.—*S. G. Henderson.*

BUCKY, PAUL C., and SPEIGEL, IRVING J. An unusual complication of the intraspinal use of iodized oil. *J. Am. M. Ass.*, June 5, 1943, 122, 367-369.

Although the intraspinal injection of iodized oil is ordinarily an innocuous procedure, the existence of a lesion which retains the iodized oil in contact with the spinal cord may ultimately result in undesirable changes in the spinal cord. In support of this the authors cite the case of a man aged thirty-six who had had low back pain beginning in 1935. It gradually became more severe and after two years spondylolisthesis was discovered. In April, 1937, a spinal fusion was performed at the fourth and fifth lumbar and the first sacral vertebrae. After this operation the patient felt quite well. However, by the beginning of 1938 he began to have severe pain in the left hip radiating down the left thigh posteriorly. In March, 1938, no neurologic abnormalities were found on examination. Iodized oil was injected intraspinaly by the lumbar route and the patient examined on the tilting fluoroscopic table. At this examination no obstruction or filling defect of the spinal canal was seen, but two large globules of oil became caught and remained at the level of the eighth thoracic vertebra. Nothing further was done. There was gradual improvement in the patient's symptoms, and by the end of 1938 he was almost entirely well and able to resume work.

About six months before admission to the Illinois Neuropsychiatric Institute on February 23, 1942, the patient began to notice that both his lower extremities were becoming weak and stiff. Weakness and stiffness progressed to such an extent that it became difficult for him to get about without using the walls and furniture for support. He also noticed that his lower extremities were becoming "numb." About four weeks before admission, the patient noticed a burning pain along the medial aspect of the right foot which came and went for varying periods of time. On lumbar puncture in February, 1942, an almost complete spinal block was found. At operation on March 10 two collections of encysted iodized oil in the subarachnoid space and

a very much thickened arachnoid membrane were found and removed. Within a few weeks after the operation the patient had made a nearly complete recovery.

It is concluded that this patient suffered from a localized adhesive arachnoiditis at the level of the eighth thoracic vertebra prior to the injection of the iodized oil. This arachnoiditis caught and held some of the iodized oil, which in turn stimulated fibroblastic proliferation in the leptomeninx, thus increasing the arachnoiditis and resulting in dysfunction of the spinal cord.—*S. G. Henderson.*

SAMUEL, ERIC. The significance of some developmental abnormalities of the hip joints. *Brit. J. Radiol.*, Aug., 1943, 16, 250-254.

The roentgen appearance of congenital dislocation of the hip is well known but there are some lesser congenital abnormalities about which little is known. These may and very often do lead to osteoarthritis in later life. At first they cause little inconvenience to the civilian but under the greater stress of military life they may cause considerable pain and difficulty in walking.

The technique of examination for these abnormalities is described. With the medial sides of the balls of the two great toes touching each other and the heels 2 inches apart, the degree of anteversion and torsion of the shaft of the femur is shown approximately by the position of the lesser trochanter. The direction of the acetabulum in relation to the coronal plane of the pelvis can also be estimated.

A separate center of ossification often appears at the upper border of the acetabulum and forms a separate bone known as the os acetabuli. This causes no symptoms. It was found in many cases of the author's 107 cases examined for hip-joint symptoms.

Varying degrees of failure of development of the fossa of the acetabulum occur in congenital dislocation of the hip joint. Minor degrees of this failure of development cause congenital subluxation which is not so generally recognized. The roentgen signs are changes in the joint space, the lower part of which is widened while the upper part is narrowed from upward displacement of the shaft, and shallow and poor development of the acetabulum. There is never a very marked degree of upward displacement of the head. There is an apparent coxa valga due to eversion of the leg to compensate for the upward displacement. Theoretically these pa-

tients should be liable to traumatic dislocation but no cases of traumatic dislocation were seen in this series. Another type of congenital dislocation is seen when there is a disproportion between the head of the femur and the acetabular fossa.

Another abnormality frequently seen is increased depth of the acetabulum. Certain markings seen on the roentgenogram around the hip joint, first described by Köhler, are of great importance in estimating the depth of the acetabulum. Sometimes the floor of the acetabulum approaches the internal wall of the pelvis progressively until a true protrusion occurs. According to Gilmour, protrusion of the acetabulum is due to abnormally early fusion of the Y-shaped epiphyseal cartilage on the floor of the acetabulum as a result of which abnormally thin bone is formed in the floor of the acetabulum which weakens under weight bearing and bulges inward. Some cases of protrusion of the acetabulum occur, however, after infectious conditions of the hip joints. A lesser degree of inward bulging causes a deep acetabulum which may contain two-thirds or the whole of the head. The joint space may be abnormally narrow throughout the hip joint. These deep acetabula frequently cause osteoarthritis.—*Audrey G. Morgan.*

MANSI, RONALD L. A case of insufficiency fracture occurring in the neck of the femur. *Brit. J. Radiol.*, April, 1943, 16, 119-120.

A case of "insufficiency" or fatigue fracture is described in a young soldier nineteen years of age. He came for treatment for slight pain in the right hip when walking. There was no history of trauma. Roentgen examination showed a fine fissure extending about a quarter of an inch into the neck of the femur. The patient was not seen again until about six weeks later when the fracture had extended completely across the neck and was practically healed in perfect position. At this time the patient was free of pain. He had not gone to bed in the interval but had been doing light office work. There was no roentgen evidence of generalized disease of the bone.

It seems surprising that there should be no displacement in this type of fracture. It is possibly because the fracture takes place so slowly that some union takes place in the first part of it before it is complete. There will probably be increasing numbers of this type of fracture in the services and roentgen follow-up of cases with a

history of persistent pain is recommended.—*Audrey G. Morgan.*

#### BLOOD AND LYMPH SYSTEM

WOLCOTT, W. EUGENE. The evolution of the circulation in the developing femoral head and neck; anatomic study. *Surg., Gynec. & Obst.*, July, 1943, 77, 61-68.

The injection method would seem to be a practical way of studying the vascular pattern in the head and neck of the femur at different age levels. By this method, the author was able to visualize the development of the blood supply which nourishes the ossifying center in the head of the femur during the entire growth period. It also was possible by this method to locate the course of the vessels within the femoral neck and head which nourish the growth area from the beginning through to its completion. This knowledge should prove to be helpful in the approach to a better understanding and treatment of certain hip conditions met in children especially Legg-Perthes' disease and the so-called slipped epiphysis. The author concludes:

1. The ossifying center in the developing head of the femur in infants and children receives its blood supply from the visceral capsule vessels which arise from the median circumflex artery.

2. The ligamentum teres vessels do not enter the head of the femur in children nor do they contribute to the nourishment of the growing femoral head, except for very small vessels which accompany the fibrous tissue at the implantation of the ligamentum teres into the fovea area.

3. The anastomosis between the ligamentum teres vessels, the capsular arteries and the nutrient artery of the shaft does not take place until the ossification of the head of the femur is practically complete, at which time the vessels of the three systems unite by penetrating the thinned out cartilage area at the fovea, thus establishing the anastomosis.

4. The ligamentum teres circulation is a closed circulation so far as the femoral head is concerned until such an anastomosis takes place.—*Mary Frances Vastine.*

HARPER, R. A. KEMP. Radiological changes in carotid-cavernous aneurysm. *Brit. J. Radiol.*, May, 1943, 16, 150-152.

Two cases of carotid-cavernous aneurysm are described and roentgenograms given showing



the bone changes that accompanied them. Thirty-eight spontaneous cases and 80 traumatic cases have been reported in the literature. In 2 of the spontaneous cases similar bone changes occurred; in 1 traumatic case there were changes in the anterior fossa of the skull which may have been due to some other cause.

The changes consist of erosion of the sella with thinning of the lateral wall, and thinning and erosion of the clinoid processes and the sphenoidal ridge with slight enlargement of the sphenoid fissure and optic foramen. In the 2 cases described here such changes had persisted for twenty years and one year respectively after operation for the aneurysm. The degree of bone change depends on the severity of the process, that is the size of the tear in the internal carotid artery inside the cavernous sinus, the time before operation is performed and the degree of success of the operation.—*Audrey G. Morgan.*

SOSMAN, M. C., LEVINE, S. A., and BAILEY, ORVILLE. [Syphilitic aneurysm of aortic arch with compression and erosion of esophagus and left main bronchus.] *Radiology*, July, 1943, 41, 64-69.

At this clinico-pathological conference the case of a fifty-two year old unmarried Irish domestic was considered. She came with a clinical picture suggesting aneurysm of the aorta—pain between the scapulae not related to effort, paralysis of the left vocal cord, cough and finally evidence of obstruction of the superior vena cava. Roentgen examination, on the contrary, seemed to show bronchogenic carcinoma. The roentgenograms are reproduced. The blood tests for syphilis were negative. In the belief that it was a tumor and the hope that it might be radiosensitive, roentgen treatment was given. This was followed by dyspnea and deep cyanosis. She became unconscious and had several attacks of this kind during the remaining week of her life. Independent of these attacks, she had two episodes of auricular fibrillation each lasting about four hours. Anemia increased rapidly, respiration gradually failed and the patient died in coma. Autopsy showed syphilitic aneurysm of the arch of the aorta with compression and erosion of the esophagus and left main bronchus. The evidence was pretty evenly matched in this case for aneurysm and tumor and the points in differential diagnosis are considered. The purely clinical diagnosis of aneurysm was obscured in this case by the laboratory tests and roentgen examination which usually prove so helpful.—*Audrey G. Morgan.*

DEBAKEY, MICHAEL, SCHROEDER, GEORGE F., and OCHSNER, ALTON. Significance of phlebography in phlebothrombosis. *J. Am. M. Ass.*, Nov. 20, 1943, 123, 738-744.

Until recently, combative measures in pulmonary embolism have been singularly ineffective. Solution of the problem consists essentially in prophylaxis. The direction of attack must be focused on the prevention of fragments of an already existing thrombus from reaching the pulmonary vascular channels. Obviously the logical means of doing this is by blocking or ligating the venous channel central to the site of the thrombus. The practical application of proximal venous ligation in the prevention of pulmonary embolism has been difficult due to the frequent absence of precise criteria in determining or in predicting the possible occurrence of embolism. For this reason, some have advocated routine division of the femoral vein in all patients who have or are suspected of having thrombophlebitis of the deep veins of the lower leg. In thrombophlebitis the clotting is believed to be the result of injury to the vascular endothelium from mechanical trauma, bacterial invasion or chemical injury, whereas in phlebothrombosis it may be due to venous stasis and to alterations in the cellular and fluid constituents of the blood that increase the clotting tendency. In thrombophlebitis the clot is usually firmly adherent to the vein wall and is therefore less likely to become detached and to result in embolism. In phlebothrombosis, on the other hand, the thrombus is loosely attached to the vessel and is more likely to cause embolism. The development of phlebothrombosis is apt to be insidious and symptoms may be obscure. The patient does not appear so sick as in thrombophlebitis, but restlessness and anxiety are frequently present. Hence, a precise method of diagnosis of intravascular thrombosis is desirable. Herein lies the importance of phlebography.

Phlebography is simple technically and is a relatively safe procedure. The patient is placed on the roentgenographic table on his back with a 7 by 17 inch film under his leg and lower thigh. A tourniquet is applied to the thigh just below the fossa ovalis and just tight enough to occlude the superficial circulation. The leg and thigh are internally rotated in order to separate the shadows of the tibia and fibula and secure unobstructed visualization of the veins. Twenty cubic centimeters of a 35 per cent diodrast solution is injected into any vein on the dorsum of

the foot or ankle at the rate of 1 cc. per second. Twenty seconds after the injection is completed the film is exposed. By employing a tube-film distance of 6 feet in which parallel rays will reach the film, it is possible with two films placed in tandem to visualize the venous system of the entire lower extremity. Twenty-five cubic centimeters of diodrast solution is injected and the exposure is made approximately thirty seconds after completion of the injection.

Normally both the deep and the superficial veins of the leg and thigh fill with the contrast substance and are clearly delineated on the roentgenogram. Incomplete or irregular filling or absence of filling is an indication of thrombosis. If the deep veins are thrombosed, the superficial veins fill and are dilated. If a defect in the venous system is visualized, indicating the presence of a thrombus, steps should be taken immediately to prevent its detachment, either by ligating the vein above the site of the thrombus or by removing the thrombus.

Eleven case histories are given together with illustrative roentgenograms.—*S. G. Henderson.*

WILLIAMS, D. A. Arterio-sclerosis; a case report. *Brit. J. Radiol.*, May, 1943, 16, 142-143.

A woman, aged fifty-two, had had progressive debility for a year and had become very forgetful. Her general condition was poor. On the ring finger of the right hand were two small ulcers caused by the prick of a thorn. There was also a superficial ulcer above the left external malleolus. There was some cyanosis of the toes. There was marked generalized arteriosclerosis and the blood pressure was 170/100 mm. Hg. Wassermann and Kahn tests were negative. The urine showed a few granular casts and some leukocytes and red blood cells. She became drowsy and died in uremia.

Autopsy showed the skull softer than normal with an appearance suggesting decalcifying osteitis. The kidneys were very much atrophied and the capsules adherent. There was intense atrophy of the parenchyma with fibrosis. Most of the tubules that remained were dilated and filled with hyaline casts giving an appearance resembling that of thyroid tissue. The kidneys were shrunken and the vessels thick walled. The aorta and its terminal branches were atheromatous. The coronary arteries were markedly arteriosclerotic. There was extensive calcification of both intima and media. The lungs showed emphysema, edema and bronchopneumonia.—*Audrey G. Morgan*

FLYNN, JAMES M. Erythroblastic anaemia with a review of the literature. *Brit. J. Radiol.*, June, 1943, 16, 157-165.

A case of erythroblastic anemia in a boy of Italian parentage eight years of age is described and illustrated with roentgenograms. He showed definite pallor with a slight icteric tint at eight months of age. As the years passed he developed mongoloid facies, his abdomen became more and more prominent and edema began at the ankles and progressed upward to the upper limbs. He was given seven transfusions in the course of several years. He is now acutely ill with protruding abdomen, pallor, cyanosis of the lips, generalized edema and dyspnea.

This disease occurs usually along the Mediterranean or in children whose parents came from there. It is characterized by enlarged spleen and liver, pallor, icterus, and in the blood picture anisocytosis and poikilocytosis and a peculiar achromia. There is hyperplasia and thinning of the cortex of the bones, the changes in the skull bones causing the mongoloid facies. Target cells are a characteristic finding. These are so called because of their resemblance to bull's eyes or targets. Their significance in the blood picture is not known. Neither is the cause of the disease known though there is some evidence that it is due to damage of the blood-forming system by congenital malaria. It generally begins in early infancy and the children die before adolescence, though a number of cases have been reported in adults. No treatment has been found effective, though liver, cod-liver oil and various medications have failed. Some rather good results and some failures have been reported from roentgen treatment though it has not been tried extensively.—*Audrey G. Morgan.*

FALKENSTEIN, DOROTHY, and FOWLER, WILLIS M. Acute lymphatic leukemia in childhood. *Am. J. Dis. Child.*, March, 1943, 65, 445-454.

The authors reviewed the cases of 61 consecutive patients with acute lymphatic leukemia admitted to the pediatric service. All patients were under sixteen years of age. They found that the aleukemic and leukemic forms of acute lymphatic leukemia in childhood occur with about equal frequency. They present no essential differences in their clinical picture except that the leukemic form tends to pursue a somewhat more acute course and to produce more pronounced lymphoid hyperplasia. The aleu-

kemic form is more difficult to diagnose and is more easily mistaken for aplastic anemia, arthritis or an acute infectious process.

High voltage roentgen therapy was tried for 15 children with enlarged mediastinal nodes and for children in whom pressure manifestations from enlarged nodes were present. Such therapy relieved the pressure symptoms and consequently made the patient more comfortable. In this way it prolonged life. In some instances in which roentgen therapy was tried it apparently made the condition worse by greatly increasing the already elevated metabolic rate and hastened the fatal outcome. The authors therefore believe that roentgen therapy should be used only for the relief of pressure symptoms or for the relief of localized pain and that such therapy is contraindicated in the absence of these features.—*R. S. Bromer.*

HOWES, WILLIAM E., and LEVIN, BELLA. Lymphosarcoma: a statistical study and evaluation of treatment. *Radiology*, June, 1943, 40, 565-580.

Lymphosarcoma is highly malignant and though the tumor may disappear under irradiation the general disease progresses. Lymphosarcoma may develop in any organ that has a basic reticulum structure, such as lymphoid tissue, spleen, liver or bone marrow. Illustrative cases in different regions are described and illustrated with roentgenograms, and details of the treatment in the individual cases given.

In general, the authors believe treatment should begin with small doses and gradually increased until a sterilizing dose of 3,000 r has been given to the tumor in three weeks. A diagram is given showing the theoretical location of roentgen portals for treatment of widespread lymphosarcoma. When metastasis has taken place, irradiation should be given not only to the visible tumors but also to the mediastinum and retroperitoneal regions.

From October, 1936, to October, 1940, forty-seven cases of proved lymphosarcoma were admitted to the Brooklyn Cancer Institute. The patients ranged in age from fourteen weeks to seventy-five years. Thirteen of them are still living two to six years after treatment; 9 have no evidence of tumor and appear to have been cured by surgery or irradiation, or both. Among 36 patients with generalized lymphosarcoma, 4 have survived two to six years. In these cases apparently irradiation delayed the course of the generalized disease.

In the discussion Dr. Leucutia suggested that it might be better to give larger doses at one time rather than using the fractional, protracted method advised by Dr. Howes. Dr. Howes said he had sometimes given a large initial dose which was followed by disappearance of the tumor but also by death of the patient.—*Audrey G. Morgan.*

#### GENERAL

GAGE, H. COURTNEY, and WILLIAMS, E. ROHAN. The radiological exploration of sinus tracts, fistulae and infected cavities. *Brit. J. Radiol.*, Jan., 1943, 16, 8-21. Reprinted in *Radiology*, Sept., 1943, 41, 233-248.

Roentgen examination may show the nature and site of deep-seated sinuses and fistulae which could not be diagnosed in any other way. A high standard of technical precision is necessary in order to explore sinus tracts effectively. The radiologist responsible for the interpretation should perform the actual injection as the pressure variations felt by the injecting hand must be immediately correlated with the visual appearances. The two chief methods of examination are the fluoroscopic control method and the fractional injection method (without pressure release) with roentgenograms taken at suitable intervals. The best contrast medium is iodized oil. Both lipiodol and neohydriol have proved very satisfactory. The technique of the injections and the instruments used are described in detail.

The following classification of sinuses and fistulae based partly on etiological and partly on anatomical grounds is given: (1) sinuses due to infective bone foci; (2) sinuses or fistulae from infected membranous sacs; (3) fistulae having their origin in some visceral infective or ulcerative focus; (4) sinuses or fistulae mainly confined to the superficial fascia; (5) sinuses or fistulae associated with vestigial and developmental anomalies; (6) sinuses or fistulae of simple traumatic origin, by puncture or laceration. Cases of these various types are described and illustrated by roentgenograms. In bone fistulae the contrast between the lipiodol and the bone may not be sufficient for an appreciation of detail in ordinary roentgenograms. In such cases the Potter-Bucky diaphragm and high kilovoltage should be used, even in the limbs. Judgment as to whether this is necessary can be based on the routine preliminary films. In sinuses of infected membranous sacs it is seldom necessary to inject more than 40 cc.; 20 cc. is often

enough. Then changes in the posture of the patient are made until the cavity is completely outlined.

Filling defects in the walls of sinuses are sometimes puzzling. They may be due to the presence of sequestra, to coarse scar contractions, to thick inspissated pus, to calculi or to air bubbles. The globulation of lipiodol, providing continuity of the injection column is maintained, indicates that the oil has entered a fluid medium. If sinuses have not been irrigated recently it suggests the entry of the oil into a pus pocket.—*Audrey G. Morgan.*

LICHSTEIN, JACOB, and SOLIS-COHEN, LEON.

Familial tuberous sclerosis (epiloia) without adenoma sebaceum. *J. Am. M. Ass.*, June 12, 1943, 122, 429-432.

Although tuberous sclerosis (epiloia, Bourneville's disease) is considered a rare and unusual entity, yet in sixty years from the time Bourneville first described it in 1880 down to 1940, 112 reports have been collected dealing with this disease and its related neurocutaneous syndromes (Recklinghausen's neurofibromatosis, angiomas cerebri or Sturge-Weber's disease, and von Hippel-Lindau's disease). In recent years the roentgenologist has become more alert to the significance of metastatic calcifications (calcified plaques) in survey roentgenograms of the skull as an identifying feature of tuberous sclerosis.

The following symptoms may be seen: (1) epileptic seizures, (2) mental deficiency, (3) adenoma sebaceum (acneform eruption, butterfly or bat wing in distribution, involving nasolabial folds and having a trigeminal distribution), (4) congenital tumors of the eye (van der Hoeve's phacoma) and of other organs including rhabdomyomas of the heart and kidney (hypernephroma or Wilms' tumor), (5) periungual fibromas, (6) cystic changes in the small bones, (7) other less frequent congenital defects including such conditions as harelip, cleft palate, pulmonary artery stenosis, microcephaly and accessory digits, and transposition of the great vessels. Sclerotic, potato-like patches are scattered over the surface of the brain, and from this characteristic the name tuberous sclerosis is derived. Subependymal proliferations may be found in the lateral ventricles closely associated with the choroid plexuses. Abortive and latent forms of the disease lacking a fully developed picture have been recognized. Adenoma seba-

ceum appears to be evidence of a general ectomesodermal disturbance.

The discovery of discrete calcified intracranial deposits renders it incumbent on the observer to incriminate or exclude, in addition to tuberous sclerosis, a number of causes. These may be (1) calcified hemorrhagic foci due to birth injury, (2) tuberculomas, (3) calcified multiple angiomas, (4) parasitic disease (calcified *ecchinococcus* cysts), (5) disturbance in calcium metabolism as seen in parathyroid disease, (6) old abscesses as a result of meningeal disease or pachymeningitis.

The authors describe 2 cases of familial multiple cerebral calcifications associated with epileptiform seizures. They believe that the additional evidence in 1 case of mental deficiency, congenital eye defect, localization of the calcified masses to the lateral ventricles by pneumoencephalography and the presence of calcifications in the other case in the region of the ventricles justifies the diagnosis of tuberous sclerosis (epiloia). The more frequent use of roentgenography and pneumoencephalography is recommended in cases of epilepsy to establish the diagnosis of this neurocutaneous syndrome, even in the absence of adenoma sebaceum.—*S. G. Henderson.*

KERLEY, PETER. The etiology of erythema nodosum. *Brit. J. Radiol.*, July, 1943, 16, 199-204.

Most of the studies of the etiology of erythema nodosum have been made on children and young adults. The author has made a careful study of 37 adults aged from eighteen to thirty-three. Generally there was a prodromal stage of three to ten days with malaise and anorexia. This was followed by a temperature of 99 to 101° F., and after twenty-four to forty-eight hours the rash developed. More than half the patients had coryza or pharyngitis with dry cough. Blood counts did not show any consistent abnormality. There were no abnormal physical findings in the chest.

Roentgen examination showed enlarged bronchial glands and pulmonary infiltration in 28 of the cases; in 9 cases there was no evidence of intrathoracic disease. Patients with such findings are frequently diagnosed as tuberculous and sent to sanatoria. These gland enlargements can be differentiated from those of lymphoblastoma by a test dose of roentgen radiation. The glands in erythema nodosum do not respond to such

treatment while those of lymphoblastoma respond quickly. Three types of lung change are described—coarse reticular striation radiating from the hila, widely disseminated, round or oval foci, and a diffuse interstitial fibrosis.

The most common theory of the etiology of erythema nodosum is that it is an allergic reaction to many bacterial and chemical toxins. Other authorities believe that it is a manifestation of tuberculosis. The arguments against the allergic therapy are presented. In all but 1 of these cases all possible drugs and diseases could be eliminated except tuberculosis, Boeck's sarcoidosis and streptococcal infection. The findings in these cases resembled those of sarcoidosis rather than those of tuberculosis. In 2 cases eye lesions strongly suggestive of sarcoidosis developed. The literature on sarcoidosis shows that erythema nodosum develops in about 25 per cent of the cases. The absence of splenic enlargement and phalangeal changes argues against sarcoidosis but all the manifestations of the disease are seldom found in the same individual. The high percentage of cases with swollen and painful joints might be regarded as an argument in favor of rheumatic streptococcal infection but the joint lesions disappeared in a few weeks.

Although no final conclusions can be reached on the basis of 37 cases, the author concludes that at least in the cases with obvious visceral manifestations the condition is a sarcoidosis. Erythema nodosum in adults might be divided into two groups—those with and without visceral manifestations. In the former group the finding of enlarged bronchial glands and lung changes does not indicate tuberculosis.—*Audrey G. Morgan.*

WILLIAMS, E. ROHAN. Calcinosis. *Brit. J. Radiol.*, Sept., 1943, 16, 286.

Calcinosis is an interesting form of pathologic calcification. It may occur in a universal or circumscribed form. The circumscribed form generally occurs in middle-aged or elderly women and is generally confined to the upper limbs, calcium deposits being found in the dermal and subdermal tissues. The fingers are particularly apt to be involved. The universal form generally occurs in children and is much more serious than the form described above. Deposits are found in the skin, subcutaneous, muscular and fascial tissues throughout the body.

Roentgenograms are given of a girl of twelve years of age showing an advanced degree of calcinosis universalis. In the right thigh the adductor group of muscles were involved and in the left the sartorius muscle.

Calcinosis is not a straightforward form of either dystrophic or metastatic calcification but may be a combination of the two types of pathologic calcification.—*Audrey G. Morgan.*

## ROENTGEN AND RADIUM THERAPY

FLEMING, J. A. C. Carcinoma of the thoracic oesophagus; some notes on its pathology and spread in relation to treatment. *Brit. J. Radiol.*, July, 1943, 16, 212-216.

The results of treatment of cancer of the esophagus are very poor by any method of treatment. Squamous epithelioma of the esophagus, which is the most frequent type of malignant growth of this region, is radiosensitive and would seem to offer favorable chances for cure. But there is a considerable period between the beginning of the disease and the appearance of symptoms, generally five or six months. Metastases are very apt to occur during this period, making irradiation hopeless. Because of the inaccessibility of the esophagus and its lymphatic field, the presence and extent of metastases cannot be determined by clinical methods. The examination of postmortem material seems to show that there is a definite relationship between the extent of the primary lesion and the degree of metastasis. Generally very long, narrow fields have been used in the roentgen irradiation of cancer of the esophagus but it has been found that if the length of the involved area is more than 5 cm. there is little if any hope of radical cure. If the length of the involved area is less than 5 cm., shorter and wider fields may be used, thus increasing the zone of irradiation around the tumor without increasing the total volume dose given the patient. The width of such fields must be limited, however, sufficiently to avoid injury of the lung fields. Tables are given showing the average length of symptoms before treatment and the average length of survival after treatment.—*Audrey G. Morgan.*

BROWN, SAMUEL, WEISS, H. B., IGLAUER, SAMUEL, and FINE, ARCHIE. Carcinoma of the trachea: report of two cases diagnosed and treated by roentgen rays. *Radiology*, Oct., 1943, 41, 394-397.

Though carcinoma of the trachea is not so rare as was formerly supposed there has been very little success in its roentgen diagnosis. The authors believe that this failure is due to the use of the ordinary technique and to the practice of stereoscopic examination of the chest in the anteroposterior position. In this position the trachea is practically obscured by the bones of the spine and the sternum. But the oblique or lateral positions show the whole course of the trachea and should always be used with the esophagus filled with barium. The presence and size of the tracheal tumor will be shown by the impression which it makes on the esophagus.

Two cases are described which were diagnosed in this way and given roentgen treatment. The response was good in both cases. One of the patients is alive and in good health after three years and the other died of a complicating heart disease.—*Audrey G. Morgan.*

FRICKE, ROBERT E., and PASTORE, PETER N.  
Radium treatment of granular or hypertrophied lateral pharyngeal tonsillar bands. *Radiology*, Sept., 1943, 41, 256-260.

The lateral pharyngeal bands are linear patches of lymphoid tissue which lie in the most lateral portion of each side of the pharynx, posterior to the pharyngeal palatine arch, and usually extend into the salpingopharyngeal fold. They tend to hypertrophy after tonsillectomy or adenoidectomy and in that case may cause severe sore throat. In the type of band seen most frequently the surface of the inferior half of the salpingopharyngeal fold has a finely granular appearance. When not acutely inflamed this type of band may readily be overlooked.

As lymphoid tissue is particularly susceptible to irradiation, this method of treatment has been successfully used in these cases. The authors discuss 24 cases treated at the Mayo Clinic in all of which the results were good, sore throat and frequent colds being overcome and the general health improved. They have devised a simple and practical applicator for these cases, which is illustrated. A metal rod is threaded at the end so that a brass and silver tube containing radon can be attached; there is a hinged joint just behind the attachment. The end of the rod with the tube containing the radon attached is passed through the nostril; on turning, the hinged portion drops downward and lies against the hypertrophied band with

the long axis of the radon pressing against the lateral pharyngeal wall.

The effect of irradiation on lymphoid tissue is transient and it may be necessary to repeat the treatment in some of these cases.—*Audrey G. Morgan.*

MANDEVILLE, F. B. Roentgen therapy of orbital-pituitary portals for progressive exophthalmos following subtotal thyroidectomy. *Radiology*, Sept., 1943, 41, 268-271.

Malignant or progressive exophthalmos is a form of the disease which tends to progress after subtotal thyroidectomy. Since 1929 varying opinions have been expressed as to the value of treating such cases by irradiation of the orbits. The literature of the subject is reviewed and one case is described which was treated by the author with good results.

The patient was a trained nurse fifty years of age on whom thyroidectomy was performed for exophthalmic goiter. About one year after the operation progressive exophthalmos was noticed which grew worse under the treatment of general physicians and ophthalmologists. Roentgen treatment was started nine months after this exophthalmos began and twenty-one months after the subtotal thyroidectomy. Treatment was given to both right and left temporal regions, using 200 kv., on a Villard circuit with tube in air, half-value layer 1.8 mm. copper, filter 2 mm. copper and 1 mm. aluminum, 20 ma., 50 cm. distance and fields 6×8 cm., angling posterior to the eyeball and toward the pituitary. Each side was given a dose of 150 r on alternate days, up to a total of 900 r on each side, well over 1,000 r on the skin. She had discomfort consisting of swelling of the orbital tissues and lacrimation for about two weeks, after which the exophthalmos receded; there was remarkable improvement in vision and movement of the eyeballs was no longer limited. Pain disappeared. Eight weeks later, a second series was given with lower voltage and less filtration with a total dose of 600 r in air on each side. There was a mild reaction two weeks after the second series which lasted only a few days. Four months after treatment the patient was clinically well and carrying on her daily duties.—*Audrey G. Morgan.*

LEDY, EUGENE T. Roentgen therapy for bronchiogenic carcinoma. *Radiology*, Sept., 1943, 41, 249-255.



Surgery is still to be recommended for operable cases of bronchiogenic carcinoma, but the author finds irradiation an excellent palliative measure in inoperable cases or those in which the patient refuses operation. Reports in regard to treatment and results are quoted from various authors. Some have claimed that no prolongation of life results from roentgen treatment but this is disproved by a series of 250 cases treated by the author and Moersch. Roentgen therapy was used in 125 cases and in the other 125 cases which were used as controls neither roentgen therapy nor surgery was used. All of the cases in which roentgen therapy was used were inoperable. In the group of cases in which no treatment was given none of the patients lived more than a year after the diagnosis was made. But 25 of the 125 cases in which roentgen treatment was used lived from one to twelve years. Five of the patients lived more than five years.

In most cases of malignant disease of the lungs the patients are debilitated and past middle age and are therefore poor subjects for any form of treatment. As palliative results are the most that can be expected in most cases, careful clinical judgment must be used in regard to the method of treatment. The author has found that the simple cross-firing of the lesion with moderate doses of roentgen rays has been as valuable clinically as that obtained by more radical methods and at the Mayo Clinic, where this work was done, the results have not been in proportion to the size of the dose. The technique used there is described in detail. As the injuries reported by some authors were due to the large doses the way to prevent them seems obvious.—*Audrey G. Morgan.*

DANN, DAVID S., and KORITSCHNER, ROBERT. Preoperative roentgen therapy of breast carcinoma: analysis of histologic reaction and roentgen technic. *Radiology*, Sept., 1943, *41*, 213-224.

The authors discuss 10 cases given preoperative roentgen treatment. Detailed histories and pathologic reports are given and the pathologic findings illustrated by photomicrographs. Two techniques were used: the first used in all but one of the cases was: 200 kv.; 20 ma.; 1 mm. copper and 1 mm. aluminum filter, 80 cm. distance, half-value layer 1.425 mm. copper; 9.16 r (in air) per minute. The daily dose to the skin was 100 r (in air); the time of administration

was 10.91 minutes. Two breast ports and, after completion of the breast irradiation, three axillary ports were treated daily with cones. The apparatus used was a General Electric KX-3, half-wave rectification. The technique used in the other case was: 250 kv., 15 ma.; Thoraeus filter plus 1 mm. aluminum; 50 cm. distance; half-value layer 2.80 mm. copper; 33.22 r (in air) per minute. The daily dose to the skin was 100 r (in air) in 3.6 minutes. Three cycles of treatment were given, each of fifteen days, with an interval of thirty-five days between the first and second and of forty-three days between the second and third. The total estimated breast tumor dose was 1,876 r in each cycle, the mid-axillary dose 1,513 r in each cycle. Two breast ports and two axillary ports were treated daily without cones. The apparatus was a General Electric 250, self-rectification.

The histological findings are discussed and special attention called to "spotty necrosis." This means that certain tissue particles may not be affected by irradiation at all. This "target hypothesis" may explain the failure of irradiation to bring about complete sterilization of these tumors. Preoperative irradiation of carcinoma of the breast does accomplish definite reduction of the size of the tumor and regressive changes which may be due to the fact that the host's defensive reaction is increased. Inoperable carcinoma may become operable after irradiation. Irradiation is recommended for inoperable cases, for operable cases in which operation is refused and for operable cases in which there are physical conditions which contraindicate operation. Further studies of the individual factors governing irradiation may lead to an improved technique for the irradiation of carcinoma of the breast.

In order to carry out such studies effectively the authors recommend the establishment of a Commission of representative radiologists, surgeons and pathologists to be appointed to plan and carry out a study of this problem. As judgment must be based on a large material, various institutions should be selected and allotted special points in the program for study. Each institution should submit to the Commission a detailed report of each individual case when the treatment is completed and follow-up observations should be made at regular intervals. Based on such detailed information in large numbers of cases the Commission can decide on the value of preoperative irradiation in general



and the comparative merits of the different methods.—*Audrey G. Morgan.*

BREWER, ARTHUR A., and ZINK, OSCAR C. Radiation therapy of acute subdeltoid bursitis. *J. Am. M. Ass.*, July 17, 1943, 122, 800.

This condition has been designated by a variety of names: subdeltoid bursitis, calcarea peritendinitis, periarthrititis of the shoulder, calcifications of the supraspinatus tendon or simply painful shoulder. By common usage it is most often called subdeltoid bursitis. Acute subdeltoid bursitis presents a very typical clinical picture. There is a rather sudden onset of severe pain in the shoulder, usually with no history of significant trauma. Exquisite point tenderness may be elicited over the area of the subdeltoid bursa, with pain radiating down the arm, limitation of motion, and muscle spasm. In typical cases the diagnosis of bursitis frequently will be verified by the demonstration of a deposit of calcium just lateral to the greater tubercle of the humerus. Chronic cases present similar but much less pronounced symptoms. The duration is several weeks, months or longer. The onset is usually insidious, although an occasional acute case may become chronic because of inadequate treatment. There is usually decided limitation of motion.

The treatment of choice should be one offering the shortest period of disability. With this in mind the authors have reviewed a series of cases treated with radiation. The physical factors employed are 200 kilovolts (constant potential), 18 milliamperes, 0.5 mm. of copper plus 1.0 mm. of aluminum filter (1.18 mm. of copper half-value layer), 50 cm. target-skin distance and a 10 by 15 cm. port directed toward the anterolateral aspect of the involved shoulder. A single treatment with a dose of 300 roentgens is usually sufficient, although this may be repeated in from seven to ten days if there has been definite but incomplete relief. The typical response in an acute case is a frequent but not inevitable aggravation of symptoms for eight to twenty-four hours. This short period of aggravation is followed by rapid relief of pain and limitation of motion, so that in most instances the patient is able to resume his normal activities in from twenty-four to forty-eight hours after treatment. The calcium de-

posits will be absent in many instances if roentgenograms are repeated in a few weeks. If there has been no improvement at the end of forty-eight hours operative treatment should be considered.

Approximately 30 per cent of the patients with chronic bursitis are improved in varying degrees, but only an occasional patient is cured by this method. If definite symptomatic relief is not apparent within ten days after treatment, the treatment is considered a failure. However, these shoulders respond poorly to any type of therapy, and it seems reasonable to submit such a patient to a trial of radiation therapy before instituting more radical measures.—*S. G. Henderson.*

BARDEN, STUART P. Healing of radiation fractures of the necks of the femora, with a report of a case. *Radiology*, Oct., 1943, 41, 389-394.

Post-irradiation fractures of the necks of the femurs rarely heal or do so only by fibrous union. The bone changes in these fractures seem to be directly proportional to the amount of radiation absorbed. A case of fracture of the necks of both femurs with complete bony healing is described and illustrated with roentgenograms. The patient was a woman of sixty-five who was being treated for a basal cell epithelioma of the urethra. She began to complain of pain in the left hip and examination showed fracture of the neck of the femur. Two years later the roentgen evidence of fracture had disappeared. Two and a half years after the fracture of the left femur the process was repeated in the right hip. This fracture also healed with bony union. No treatment was given except rest in bed and limited traction. There seemed to be no reason for the difference in time of the fractures except that a greater number of roentgens was delivered to the left femur.

As most of these fractures occur in the treatment of cancer of the cervix, the author uses small portals in this treatment, not larger than 12 cm. in diameter. When using the posterior portal the patient is cautioned to turn her toes inward and her heels outward, thereby rotating the femurs internally so that the necks of the femurs are farther away from the source of radiation.—*Audrey G. Morgan.*



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# THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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## CARDIAC CHANGES IN ARTERIOVENOUS FISTULA\*

By LIEUTENANT COLONEL ROBERT C. PENDERGRASS

*Medical Corps, Army of the United States*

ONE of the most frequent and serious vascular injuries of modern warfare is arteriovenous fistula. Multiple injuries of blood vessels, peripheral nerves, and bones result from high explosive shell fragments, bombs, grenades and mines. The opportunity to study the cardiac changes in a large number of patients with arteriovenous fistula was provided by the designation of Ashford General Hospital as a Vascular Surgery Center. Detailed reports concerning the diagnosis and surgical treatment of this condition have been made by Elkin.<sup>2,3</sup>

The effects of an arteriovenous fistula upon the circulation in general and the heart in particular are so important that the attention of roentgenologists should be called to the cardiac changes incident to this lesion. As these changes are usually reversible by elimination of the fistula, it is important that their cause be recognized. The heart changes of beriberi, myxedema and hyperthyroidism are to some extent reversible.<sup>24</sup> Constrictive pericarditis and patent ductus arteriosus offer brilliant examples of the beneficial effect of surgery; the improvement following surgical elimination of an arteriovenous fistula is equally dramatic.

William Hunter, in 1757, first described arteriovenous fistula of the vessels of the

forearm as a result of blood letting. In 1888, Delbet described 250 cases, of which 96 were the results of venesection.<sup>15</sup> Von Haberer reported 243 cases occurring in German soldiers as a result of wounds received in the first World War.<sup>12</sup> Matas,<sup>14</sup> in reviewing 620 operations on major blood vessels, reported 67 cases from civilian practice. The cardiac manifestations of arteriovenous aneurysms resulting from wounds incurred in the present war may not be evident, in some cases, until after the soldier is discharged. As a result, the condition may be encountered more frequently in civilian practice. Any patient exhibiting cardiac enlargement without obvious cause, who has received battle injuries, should be carefully examined for an arteriovenous fistula. This includes auscultation of all wounds.<sup>3</sup> In this connection, the following is a quotation from the late Mont R. Reid's contributions<sup>21</sup> on arteriovenous communications:

It is too true that we often fail to appraise properly chronic affections which, while life lasts, are no serious handicap to the individual. In cases of such affections, it becomes our duty to think of the future, of the days longer our patient may be enabled to live, and not of the day he is living when he comes to the office. It is in such manner that most abnormal ar-

\* From the Roentgenological and Vascular Surgery Services, Ashford General Hospital, White Sulphur Springs, West Virginia. Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24-29, 1944.

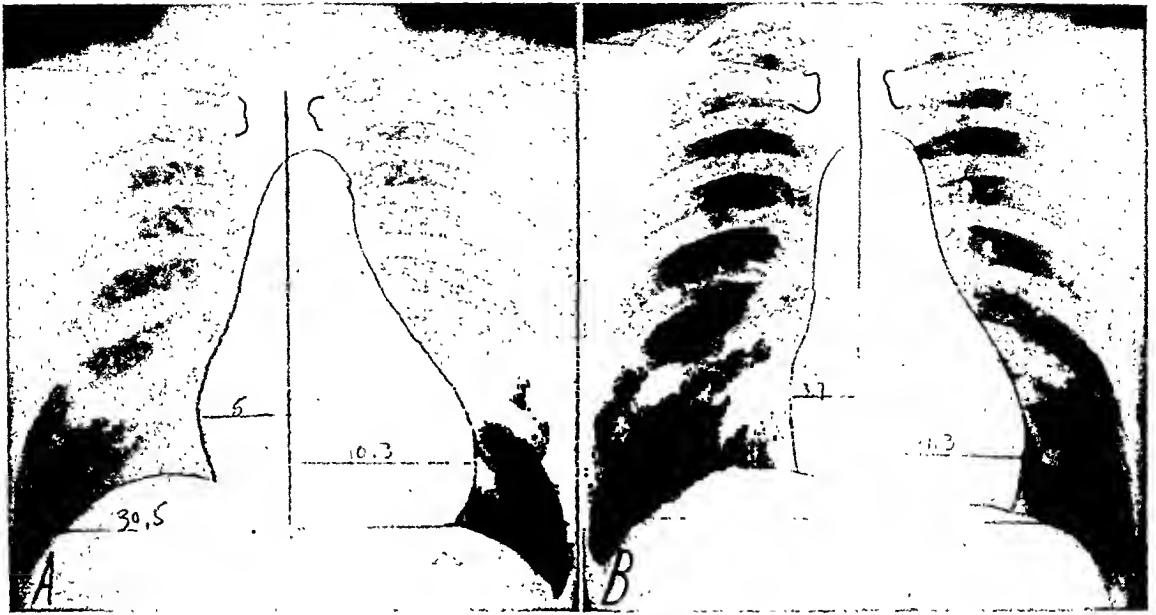


FIG. 1. Case 1. Wound of left leg December 6, 1942. Profuse bleeding. Cast for two months, followed by physiotherapy. Shrapnel removed from wound June, 1943. Further physiotherapy and return to duty. Pain and swelling of left leg on walking. Admitted February 23, 1943, over fourteen months after injury with diagnosis of arteriovenous fistula of femoral vessels. *A*, preoperative roentgenogram fourteen months after injury. Cardiac enlargement. *B*, postoperative roentgenogram, showing decrease of 2.3 cm. in transverse cardiac measurement. This case illustrates long time interval between injury and establishment of diagnosis of arteriovenous fistula. Reduction of 2.3 cm. in transverse cardiac diameter approximately three months after operation.

teriovenous communications must be considered, for they are usually chronic affections, often worrying little, but often subtracting days from the end of one's life.

Nicoladoni, in 1875, first observed a drop in pulse rate upon manual obliteration of an arteriovenous fistula,<sup>4</sup> and Branham, in 1890, independently observed slowing of the pulse following the same maneuver (Branham's sign). Stewart is credited by Dean and Dean<sup>1</sup> with being the first to call attention, in 1913, to the deleterious effect of arteriovenous fistula on the heart. Reid<sup>20</sup> showed that when fistulae were experimentally produced between the large vessels of the neck or legs, cardiac hypertrophy and dilatation would result, and in some cases, cardiac decompensation and death. Osler watched two patients, one for fifteen years and one for nineteen, who died at an early age as a result of cardiac decompensation associated with arteriovenous fistula. Matas, Leriche, Callender, Holman, and Reid have publicized the effect of ar-

teriovenous aneurysms on the heart. Reid and McGuire<sup>19</sup> reported cardiac failure developing fifteen years after production of a fistula of the profunda femoris vessels. Mason<sup>11,13</sup> has reported cardiac decompensation occurring very early after establishment of the fistula.

Elkin has reported several cases with severe cardiac damage. He states the effect on the circulation as follows:<sup>3</sup>

Establishment of a fistula [between artery and vein] introduces a secondary circuit into the vascular system. The peripheral resistance in this circuit is lowered, the capillary barrier being eliminated, and arterial blood is short-circuited directly from artery to vein. In a fistula of a large vessel, like the femoral, one-fifth to one-half of the blood ejected by the left ventricle is shunted to the right side. . . . In [most] instances, the blood pressure changes are not extreme, the systolic pressure soon returns to normal, but the diastolic pressure, as a reflection of the general lowering of the peripheral resistance, remains lowered. . . . The heart accommodates to the increased venous return by

acceleration of rate and increased strength of contraction, effecting an increase in cardiac output. Soon an increased circulating blood volume is added as another compensatory mechanism.

Holman<sup>9</sup> has shown in dogs the dilatation of the proximal artery and vein and the heart following establishment of a fistula

between the aorta and vena cava. Autopsy showed a marked increase in the size of the cardiac chambers and in the thickness of their walls. He has also measured the proximal and distal vessels in patients with arteriovenous fistula, and has shown a definite enlargement of the proximal vessels.

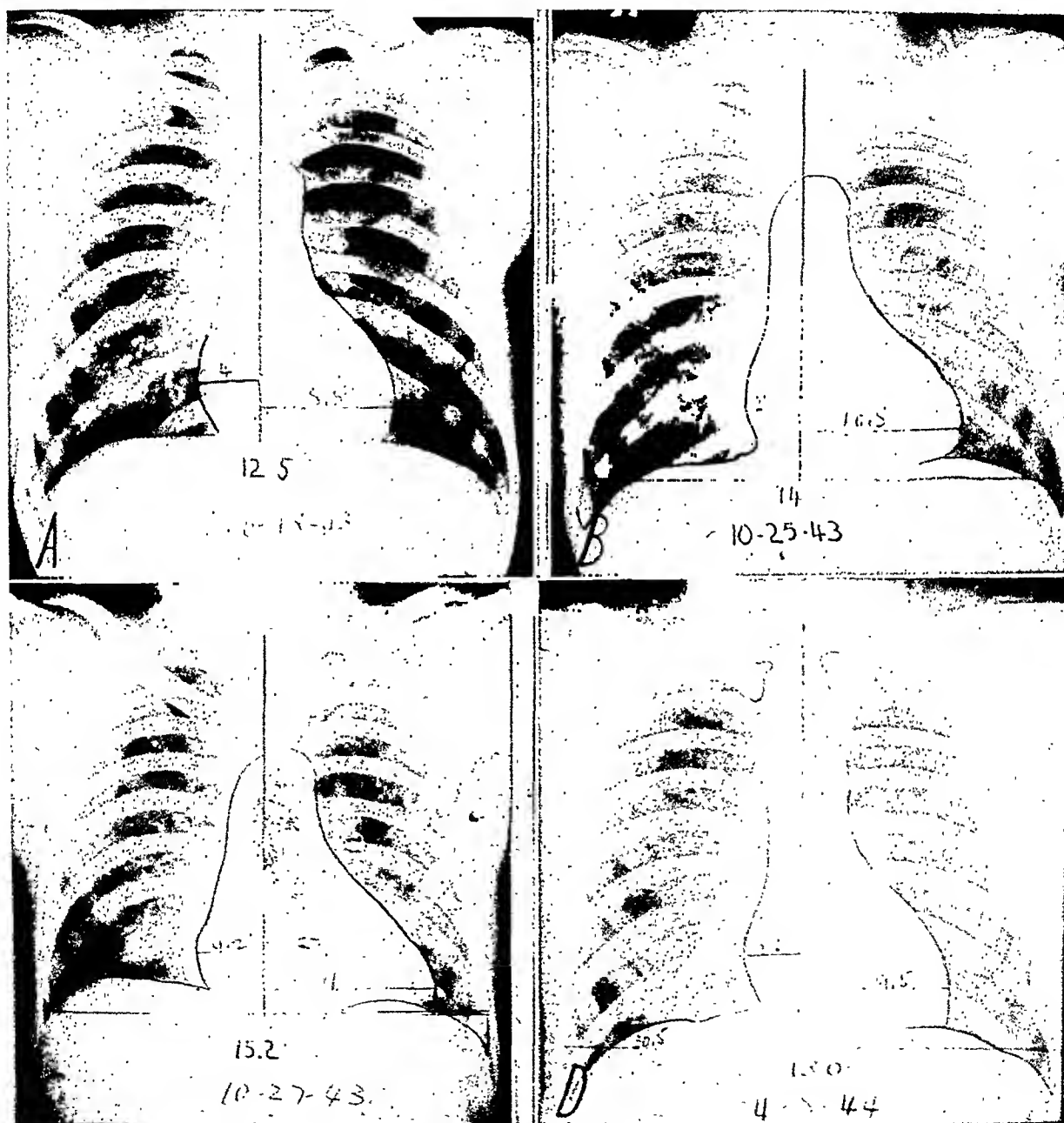
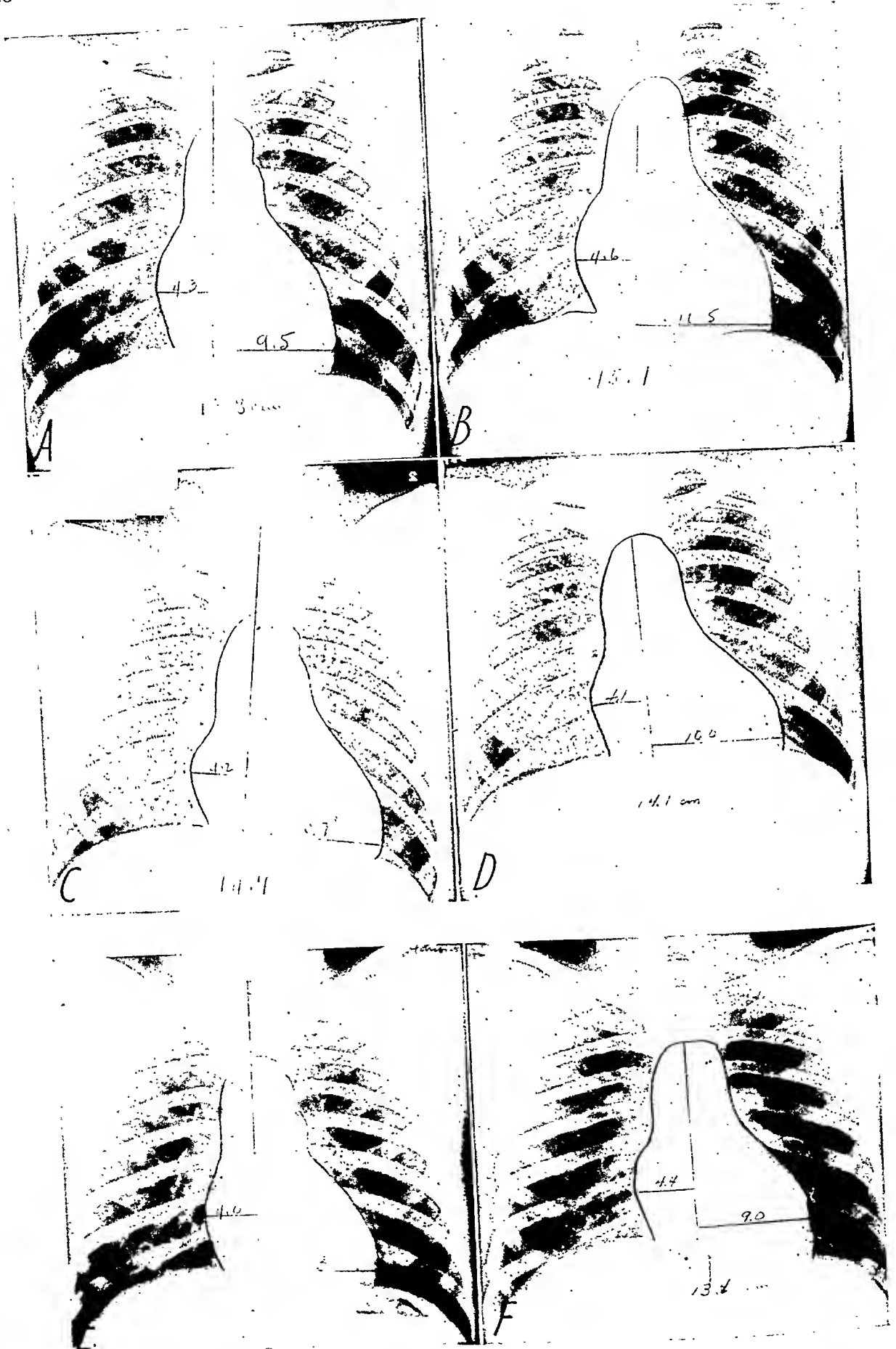


FIG. 2. Case 11. Shrapnel wound of right axilla October 15, 1943, resulting in arteriovenous aneurysm of right subclavian vessels. Resection of aneurysm November 24, 1943 (overseas). *A*, normal heart three days after injury. *B*, showing increase of 1.5 cm. in transverse cardiac diameter ten days after injury. *C*, showing increase of 2.7 cm. in transverse cardiac diameter twelve days after injury. Operation November 24, 1943. *D*, return to normal cardiac diameter four and one-half months after operation. This case illustrates early change in heart size after creation of arteriovenous fistula and subsequent return to normal size following operation.





McGuire and his associates<sup>10</sup> reviewed the clinical and experimental observations on the effects of arteriovenous fistulae in 1940. They demonstrated the following changes associated with the establishment of a large arteriovenous fistula: (a) fall in mean arterial blood pressure and acceleration of the pulse; (b) increase in cardiac output and stroke volume; (c) elevation of the venous pressure distal to the fistula, but little change in the venous pressure proximal to the fistula; (d) acceleration of the velocity of the blood flow proximal to the fistula. Retardation of the velocity of the flow distal to the fistula.

They questioned the rôle of increased blood volume in the production of heart failure, and attributed the increased blood volume to the increased capacity of the vascular bed in the collateral circulation.

Smith<sup>25</sup> studied the mechanics of the circulation in a patient with an arteriovenous aneurysm of six years' duration, before and after operation, and was able to demonstrate a reduction of 58 per cent in cardiac output, and an increase of 122 per cent in the coefficient of utilization following operation.

#### ROENTGENOLOGICAL STUDIES

The roentgenological studies incorporated in this paper have been directed at the investigation of:

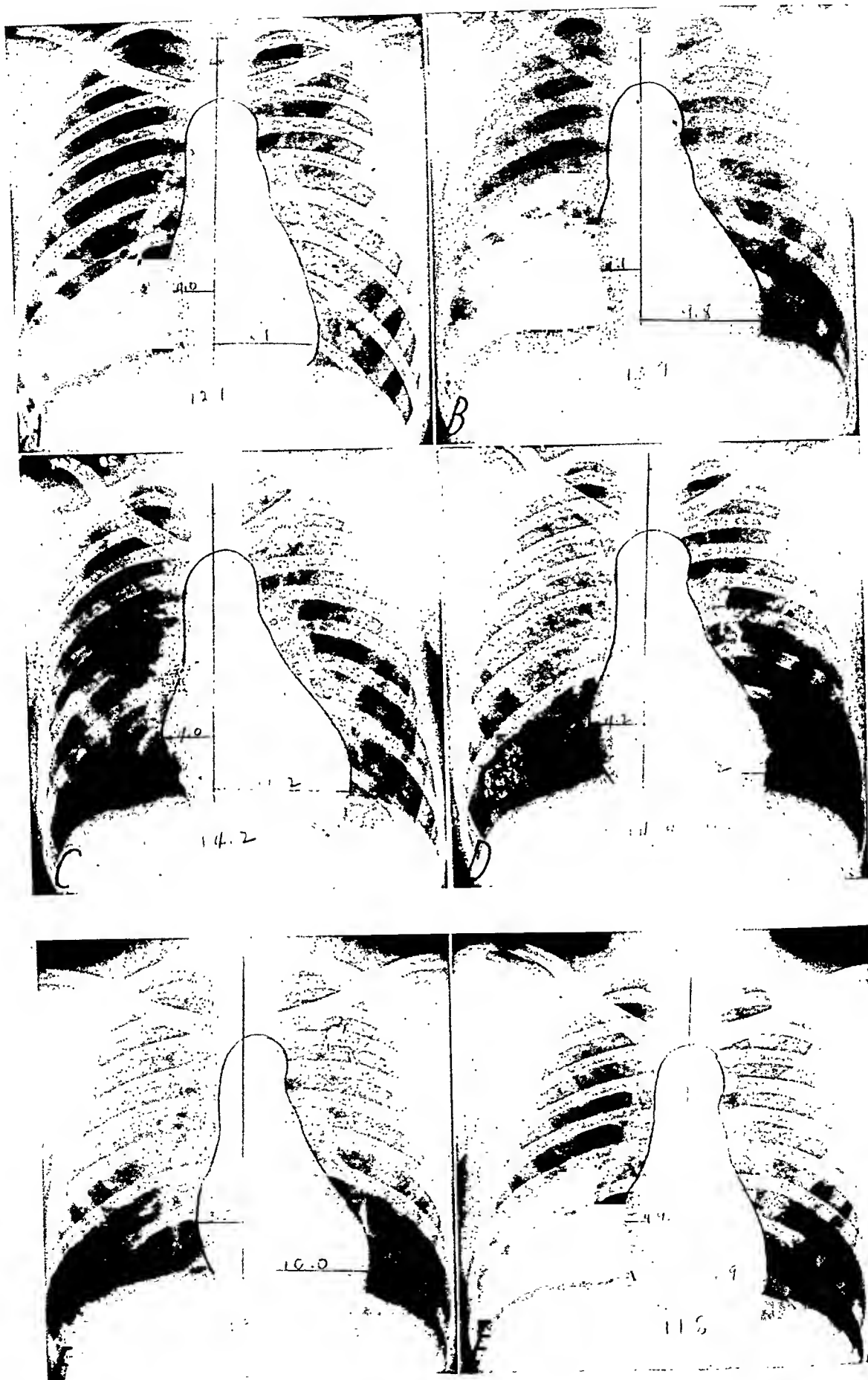
1. The detection of cardiac enlargement.
2. The effect of temporary manual obliteration of the fistula.
3. Study of the immediate postoperative changes.
4. Eventual changes in cardiac size following operative elimination of the fistula.

*Method of Study.* While practically all patients were studied roentgenoscopically, the measurement of cardiac size was based on the sum of the right and left transverse cardiac diameters on roentgenograms taken at 72 inches in full inspiration, using 150 ma., 1/10 second. Certain technical difficulties were encountered, but bedside roentgenograms were made in the erect position at 72 inches, and those showing more than 1 cm. difference in diaphragmatic level were discarded. All measurements were made by one observer. For various reasons, not all cases could be studied at the same time intervals; this explains the latitude in the interval studies after operation.

The changes in transverse cardiac diameter were, in many instances, very slight, but definite. Many of the patients examined had fistulae of relatively short duration, and extreme changes in cardiac size were not to be expected.

1. *The Detection of Cardiac Enlargement.* In most instances, previous chest roentgenograms were not available for comparison. Induction roentgenograms were obtained in a few instances, but the variability in size of films used at induction stations and in target film distances made measurement of induction roentgenograms impractical. We were able to observe definite increase in cardiac diameter when our roentgenograms were compared with transfer roentgenograms, in some cases, and one case showed definite increase in heart size during three weeks' observation in the hospital. The most striking fact evolving from studies on the existence of cardiac enlargement in arteriovenous fistula was that many cases showing normal cardiothoracic ratios and no abnormality of cardiac out-

FIG. 3. Case III. Shrapnel wound right thigh on June 13, 1944. Diagnosis of arteriovenous fistula of femoral vessels made five days after injury. Operation August 21, 1944. *A*, cardiac enlargement forty-six days after injury. *B*, increase of 1.3 cm. in transverse cardiac diameter in twenty-one days. *C*, two hours after operation. *D*, twenty-four hours after operation. Shows 1 cm. decrease in transverse cardiac diameter. *E*, forty-eight hours after operation; further decrease in heart size. *F*, seven days after operation; 1.7 cm. decrease in transverse cardiac diameter since operation. This case illustrates an increase of 1.3 cm. in transverse cardiac diameter in twenty-one days. Rapid decrease in cardiac size after operation without initial rise in first few hours after operation. Decrease of 1.7 cm. in transverse cardiac diameter seven days after operation.



line exhibited a definite decrease in cardiac measurements after surgical elimination of the fistula. In other words, the cardiac enlargement was not evident when commonly accepted standards were applied, but only became evident when the postoperative were compared with the preoperative roentgenograms. This indicates that while the cardiac changes in arteriovenous fistula may be early and dramatic in some cases, they are late and insidious in others.

In patients having true or false arterial aneurysms, and cirroid aneurysms, no cardiac changes were demonstrated on the roentgenograms.

Congestion of the pulmonary vessels was noted in a few instances and this improved after operation.

2. *Effect of Temporary Manual Obliteration of the Fistula.* Twenty-three cases were examined before and during manual obliteration of the fistula. Compression was applied until the bruit was obliterated and the pulse slowed. This was difficult to accomplish in some of the subclavian fistulae, but could usually be easily done in fistula of the vessels of the extremities.

Thirty-three per cent showed a slight increase in transverse cardiac measurements upon compression. This increase varied from 0.1 cm. to 1.1 cm., averaging 0.46 cm. Forty-five per cent showed a decrease in the cardiac diameter, varying from 0.1 cm. to 0.9 cm., averaging 0.4 cm. Twenty-one per cent showed no change on compression of the fistula. One case was examined with prolonged compression with the Matas clamp. There was an increase of 0.2 cm. at two minutes, and 0.6 cm. in five minutes after the fistula was occluded. It is prob-

able that further studies with prolonged compression might give results different from those obtained by temporary compression.

From this limited study (24 cases) it must be concluded that there is no appreciable change in cardiac size resulting from temporary occlusion of the fistula. Roentgenoscopically, the heart could be seen to slow its rate and increase the amplitude of its contractions.

3. *Study of the Immediate Postoperative Changes in Cardiac Size.* Holman<sup>9</sup> has described the postoperative changes in the heart twenty-four hours after operation, and has made roentgenographic studies of hearts of dogs within fifteen minutes after production of arteriovenous fistula. The earliest postoperative roentgenographic examination of the heart in this series was made one hour after operation, and showed a decrease of 0.9 cm. in transverse cardiac diameter. Eleven patients were examined two hours after operation; 9 showed an average increase of 0.97 cm., and 2 an average decrease of 0.45 cm. Seventeen patients were examined twenty-four hours after operation; 12 showed an average decrease of 0.61 cm., and 5 an average increase of 1.18 cm. Eighteen patients were examined forty-eight hours after operation; 8 showed an average increase of 0.6 cm., and 10 showed an average decrease of 1.01 cm. Nine patients were examined seventy-two hours after operation; 2 showed an average increase of 0.3 cm., and 6 an average decrease of 0.88 cm. Fifteen patients were examined seven days after operation; 5 showed an increase of 0.68 cm., and 10 showed an average decrease of 1.15 cm.

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FIG. 4. Case IV. Multiple wounds of lower extremities sustained on November 11, 1943. Fractured femur. In March, 1944, patient noticed "buzzing" sensation in right thigh and felt thrill. Diagnosis of arteriovenous aneurysm made, and fistula excised July 29, 1944. *A*, preoperative roentgenogram; apparently normal cardiac outline. *B*, increase of 1.8 cm. in transverse cardiac measurements three hours after operation. *C*, six hours after operation; further cardiac enlargement. *D*, twenty-four hours after operation; maximum cardiac enlargement. *E*, forty-eight hours after operation; beginning decrease in cardiac measurements. *F*, seventy-two hours after operation; cardiac measurements less than on preoperative roentgenogram. This case illustrates apparently normal cardiac measurements seven months after injury. Immediately after operation, there was enlargement of the cardiac silhouette, beginning at three hours and reaching a maximum at twenty-four hours, with decrease at forty-eight hours and return to less than original measurements at seventy-two hours after operation.

While there was considerable variation in the time of appearance and the extent of measurable increase and decrease of the transverse cardiac diameter in the above series, the tendency was toward an increase in the first two hours after operation, and beginning decrease at twenty-four hours, continued to the seventh day after operation.

Many factors are believed to contribute to the variation in cardiac size immediately following surgical closure of the fistula, but the following are probably the most important: the size and duration of the fistula; the proximity of the fistula to the heart; the degree of dilatation of the proximal vessels; and the extent to which the myocardium is able to respond to the sudden circulatory changes.

4. *Eventual Postoperative Changes.* Because the chief function of an Army hospital is to return soldiers to either full or limited duty as soon as possible, not all patients could be examined at the same postoperative intervals. Convalescent furloughs also prohibited a rigid follow-up schedule, and the existence of other injuries often necessitated discharge of patients from the service. However, a group of 32 patients were examined at intervals varying from fourteen days to six months after surgical elimination of the arteriovenous fistula. Twenty-seven patients (84.3 per cent) showed an average decrease in cardiac diameter of 1.18 cm.; 1 patient (3.3 per cent) showed an increase; and 4 patients (12.5 per cent) showed no change.

#### SUMMARY AND CONCLUSIONS

1. Arteriovenous fistula is a common vascular injury of modern warfare. Cardiac dilatation and hypertrophy, with eventual failure, may result from the establishment of such a fistula. The cardiac changes may be demonstrated roentgenographically. Roentgenologists should be familiar with this particular cardiac effect and suspect the presence of a fistula in patients with cardiac enlargement who have suffered penetrating wounds.

2. The cardiac changes in arteriovenous fistula are usually reversible by surgical elimination of the fistula. Temporary manual occlusion of the fistula produces no appreciable change in the cardiac silhouette, but further study is indicated as to the effect of prolonged compression.

3. The immediate postoperative effect is an increase in heart size, with a decrease beginning in twenty-four hours, more evident at forty-eight hours, and usually well established by the seventh postoperative day.

4. Thirty-two cases of arteriovenous fistula have been studied roentgenographically with respect to cardiac measurements before and after surgical elimination of the fistula.

The author wishes to express his appreciation to Sergeant C. W. Vatz for technical aid; Captain F. B. Hall, Corporal J. T. Jackson and Corporal V. Destro for illustrations and drawings; and to Mrs. Frances Reese for case abstracts.

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# THE SIGNIFICANCE OF CALCIFICATION IN THE ASCENDING AORTA AS OBSERVED ROENTGENOLOGICALLY\*

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and

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A CONSTANT comparison of diagnoses arrived at clinically and roentgenologically with those reached pathologically not only serves to check the accuracy of methods and observers but occasionally suggests correlations not hitherto suspected. In weekly conferences of roentgenologic-pathologic correlation at City Hospital of Cleveland, the frequent association of calcification in the ascending aorta, as seen in the roentgenogram, and the pathologic diagnosis of syphilitic aortitis was noted and discussed. Consultation of standard textbooks and medical journals yielded little information on the subject. Repetition of the observation, however, both in roentgenologic-pathologic conferences and in current clinical cases, in which calcification in the ascending aorta was associated with serological evidence of syphilis, furthered the conviction that this combination of events is more than coincidental, and that the presence of calcification in the ascending aorta is a reliable roentgen sign of syphilitic aortitis.

Calcification may occur in any portion of the aorta. Roentgenologically it is most often seen in the aortic knob of older patients in whom it is a manifestation of arteriosclerosis. Calcification is frequently observed in the walls of aneurysms which are usually syphilitic in origin but may rarely be arteriosclerotic. The presence of calcium in aneurysms has no etiologic significance but is valuable in the differential diagnosis between tumors and aneurysms especially in the mediastinal region.

Calcification in the ascending aorta, how-

ever, has been misinterpreted or completely ignored. Many have considered it a manifestation of arteriosclerosis. Others have used it to measure the diameter of the ascending aorta. That it has diagnostic significance is scarcely appreciated. Except for Schatzki<sup>13</sup> who thinks that calcification in the ascending aorta is more indicative of syphilitic aortitis than against it, no direct evidence in favor of this view could be found in the literature.

## METHOD

In order to substantiate this view the following investigation was undertaken. All pathologically proved cases of syphilitic aortitis were collected and those with roentgenograms of the chest kept for study. An equal number of autopsied cases of severe arteriosclerosis, also with chest roentgenograms, was used for comparison. Roentgenoscopic observations alone were not considered. Many of the roentgenograms in the series were not of optimum quality as a result of the grave illness of certain patients, the supine position in which some of the exposures were made, and such technical errors as motion, underexposure, and partial rotation of the patient. None of the cases of syphilitic aortitis, however, was discarded for these reasons. Since the group of arteriosclerotics was unlimited, those with inadequate roentgenograms were replaced. No special techniques to demonstrate the presence of calcification were used. All cases in which a pathologic diagnosis of aneurysm of the ascending aorta had been made were excluded

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from both groups since the significance of calcification in aneurysms of the ascending aorta is not part of the problem.

In addition to a study of the roentgenogram, such subsidiary data as age, sex, race, and the presence or absence of aortic insufficiency, and the type of Kline and Wassermann reactions of the blood and spinal fluid were collected from the clinical records. Heart weights and the presence of syphilitic stigmata were determined by examination of the autopsy protocols.

As a further control, all current clinical cases with calcified ascending aortas were investigated serologically and otherwise for evidence of syphilis.

SYPHILITIC AORTITIS

In all, 66 cases of pathologically proved syphilitic aortitis in which at least one roentgenogram of the chest had been made were studied. These were divided into two groups: those with calcification in the ascending aorta, the calcific group; and those without calcification in this region, the non-calcific group. This division depended entirely on the roentgen demonstration of calcium in the root of the aorta (Table I).

The table shows that roentgenograms of 15 of the cases (22.7 per cent) revealed calcification in the ascending aorta. Thus, it is seen fairly frequently. When it is consid-



FIG. 1. Note linear calcification of ascending aorta (arrows). This is a routine posteroanterior roentgenogram of the chest. A dark print has purposely been made to show the calcium. Autopsy showed syphilitic aortitis.

ered that the roentgen techniques used in the making of the roentgenograms were routine and that many of the roentgenograms were made under handicaps, the conclusion is justified that the figure 22.7 per cent is on the smaller rather than on the larger side. Furthermore, even if no special

TABLE I  
SIXTY-SIX CASES OF SYPHILITIC AORTITIS PROVED AT AUTOPSY

		No.	Age	Sex		Color		Serology		Heart Weight	Clinical Aortic Insufficiency	
Calcific Group												
(Calcium present in ascending aorta)	15	Av. 57	M	9	W	10	Pos.	9	359 gm.	Present	2	
		32-71 range	F	6	B	5	Neg.	3	No record	3	230-550 range	Absent
Non-calcific Group												
(No calcium present in ascending aorta)	51	Av. 52	M	41	W	24	Pos.	40	483 gm.	Present	20	
		35-75 range	F	10	B	26	Neg.	9	No record	2	175-1200 range	Absent





FIG. 2. Extensive calcification of both walls of the ascending aorta.

effort is made to demonstrate the calcium, it can be observed and interpreted in approximately one-quarter of the autopsied cases.

The amount of calcium present varied from a thin linear plaque 1 to 2 cm. in length (Fig. 1) to extensive calcification of both walls of the ascending aorta (Fig. 2). The radiopaque shadows were most commonly seen in the right border of the ascending aorta halfway between the aortic valve and the beginning of the transverse portion. In occasional cases the calcification could be demonstrated only on one or the other of the oblique views.

*Age.* The average age of the patients in which calcium was present in the ascending aorta was fifty-seven years as compared to fifty-two years for those without calcification. It is presumed, therefore, that calcification occurs only when the luetic infection is of long duration and in those cases where the disease is less severe. Nevertheless, calcification was present in one patient, a Negro female, who was only thirty-two years of age (Fig. 3).

*Sex and Color.* Fifty males and 16 fe-

males were included in the syphilitic group. Calcification was present in the ascending aorta of 9 of the males and 6 of the females. Approximately 50 per cent of the patients were Negroes.

*Serology.* Positive serological tests for syphilis were found in blood, spinal fluid, or both, of 9 (60 per cent) of the 15 cases in which calcium was present in the ascending aorta. In the non-calcific group, serological tests were positive in a higher percentage (78.4) of the cases. These figures are in fair agreement with those of Lamb,<sup>5</sup> who found positive blood Wassermann reactions in 80 per cent of proved cases, and with those of Reid,<sup>11</sup> who found negative Wassermann reactions in 17 per cent shortly before death. These figures also re-emphasize the fact that calcification occurs only when the luetic infection is of long duration and when serological evidence begins to disappear.

*Aortic Insufficiency.* Clinical evidence of aortic insufficiency was found in only 2 cases associated with calcium in the ascending portion of the aorta. As would be ex-



FIG. 3. Roentgenogram of the chest of colored female, aged thirty-two. Syphilis of the aorta. No evidence of aneurysm.

pected, the correct clinical diagnosis of syphilis of the aorta was made only in these 2 cases. This finding is in accord with the view of Levine<sup>5</sup> who has said that luetic aortitis may be "suspected if we find a positive Wassermann, but there are no signs that I know of that will tell you that luetic aortitis is present. In fact, luetic involve-

while those in the non-calcific group averaged 483 gm., a difference of 124 gm. The difference is undoubtedly due to the fact that many cases in the non-calcific group died of cardiac failure secondary to aortic insufficiency before calcium could develop in the aorta. It also implies that the "calcium sign" is a rather late finding in

TABLE II  
SIXTY-TWO CASES OF SEVERE ARTERIOSCLEROSIS OF THE THORACIC AORTA WITHOUT SYPHILITIC AORTITIS

	No.	Age	Sex	Color	Serology	Heart Weight	Aortic Insufficiency
Calcific Group (Arteriosclerosis with calcification of ascending aorta)	2	Av. 62.5 60-65 range	M 2 F 0	W 2 B 0	Pos. 1 Neg. 1	600 gm.	Present 1
Non-calcific Group (Arteriosclerosis without calcification of ascending aorta)	60	Av. 70 44-92 range	M 36 F 24	W 54 B 6	Pos. 6 Neg. 54	428 gm.	Present 0

ment of the aorta produces no physical disability until it does one of three things: produces an aneurysm and presses somewhere; closes the ostia of the coronary vessels, or produces aortic insufficiency."

These facts are highly significant. The clinical diagnosis of syphilis of the aorta is rarely made in the absence of aortic insufficiency and yet it appears that the proper diagnosis may be made from the roentgenogram alone in a certain group of cases, even though the aortic valve is competent. It is in this group that the "calcium sign" is most important since even the serological evidence may be non-contributory.

In the non-calcific group aortic insufficiency was present in 20 cases, or 39.2 per cent. Here again the correct clinical diagnosis was made when insufficiency was present. It was rarely made in the group in which the aortic valve was competent.

*Heart Weight.* The weights of the hearts in the calcific group averaged 359 gm.,

syphilis and may indicate quiescence of the lesion.

ARTERIOSCLEROSIS

Arteriosclerosis is classified by the Department of Pathology at Cleveland City Hospital as severe, moderate and slight. Only the severe cases have been included in Table II. Sixty-two such cases were chosen with the following two provisions: (1) that the pathological description implied severe involvement in the proximal portions of the aorta, and (2) that a roentgenogram of the chest was available for review. It should be noted, however, that in many of the pathological descriptions of the aorta no specific mention was made as to the presence or exact localization of the calcification. These cases were also divided into calcific and non-calcific groups, again on the basis of the chest roentgenogram.

In only 2 cases (3.2 per cent) was calcium found in the ascending aorta. One of

these had a four plus Wassermann reaction on repeated occasions and in addition had obvious aortic insufficiency. Review of the available pathological material, however, did not permit a pathological diagnosis of luetic aortitis. The other patient had a negative blood Wassermann reaction and no other indications of syphilis. The remaining 60 cases showed no evidence of calcification of the ascending aorta that could be demonstrated on the chest roentgenograms. Their ages averaged seventy years, or thirteen years more than the average age of the calcific group of luetic aortitis. Calcification was frequently seen in the aortic knob but was not present in the ascending portion except as noted above. It appears, then, that age alone, even in the presence of severe arteriosclerosis, rarely leads to the deposition of roentgenologically demonstrable calcium in the ascending aorta. The blood Wassermann reaction was positive in 6 cases and negative in 54. The average heart weight was 428 gm.

CURRENT CLINICAL CASES OF SYPHILIS  
OF THE AORTA

To test the clinical applicability of the observation that calcification in the ascending aorta is a reliable sign of syphilitic aortitis, those cases which were observed clinically during the period of this study were investigated serologically for evidence of syphilis. Twenty such cases were collected.

As will be noted in Table III, the serologic tests for syphilis were positive in 13 of the cases, or 65 per cent. Aortic insuf-

TABLE III  
TWENTY CLINICAL CASES OF CALCIFICATION OF THE  
ASCENDING AORTA

Age	Sex	Color	Serology	Clinical Aortic Insufficiency
Av. 62	M 17 F 3	W 16	Pos. 13	5
45-74 range		B 4	Neg. 7	

iciency was recorded in 5 cases. Other roentgen findings did not aid materially in the establishment of the diagnosis of luetic aortitis.

Whether the 7 cases with calcification in the ascending aorta, but without positive serologic evidence of syphilis, represent syphilitic aortitis is, of course, unknown. It should be noted, however, that the average age of the entire clinical group is sixty-two years, whereas the average age of the autopsy group with syphilitic aortitis and calcification in the ascending aorta is fifty-seven years. Only 60 per cent of the patients in the latter group had serologic evidence of syphilis. The more advanced age of the clinical group may then account for the lack of confirmatory serologic evidence of syphilis in 7 cases.

DISCUSSION

The statistical evidence just presented is consistent with the known pathologic observations in syphilitic aortitis and intimal arteriosclerosis. The latter, as a general rule, shows its greatest manifestations in the abdominal portion, especially at or near the bifurcation. Unless the disease is marked, it is common to find that the proximal portion, often including the whole arch, may escape grossly visible disease. In contrast, syphilitic aortitis affects the proximal portion and is rarely observed beyond the isthmus or mid-thoracic region. As a rule, syphilitic aortitis is most evident in the ascending aorta, particularly near its point of origin. Calcification is not frequent in syphilitic aortitis but when it occurs it develops principally in the ascending aorta. As a general rule, when calcification occurs in syphilitic aortitis the disease is marked and advanced. Anatomically it is difficult to determine arrest or quiescence of the process.

The relationship between arteriosclerosis and syphilitic aortitis is an unsettled problem. Earlier observers considered them entirely separate entities which might occur coincidentally, especially in the older groups.<sup>3,9</sup> Arteriosclerosis was looked upon

as an obscuring factor in syphilitic aortitis. Some evidence that syphilis might predispose to arteriosclerosis has been submitted by Warthin<sup>18</sup> who showed that arteriosclerosis of smaller arteries is 25 times more common in syphilitics than among non-syphilitics. However, conclusions about smaller arteries cannot be transferred to the aorta. Karsner,<sup>1</sup> in his discussion of the etiology of arteriosclerosis, believes that infectious diseases play an important rôle. Since syphilis is an infectious disease its relationship to arteriosclerosis may be inferred. Nevertheless, it is difficult to find in any of the available sources any direct connection between syphilis and arteriosclerosis. Most pathologists either consider calcification as a rare manifestation of syphilitic aortitis or the result of coincidental arteriosclerosis.

Whether the calcification found roentgenologically in the ascending aorta is the result of syphilitic aortitis or the sequel of an arteriosclerotic process initiated by syphilitic aortitis cannot be settled here. In either event the diagnosis of syphilitic aortitis can be made with acceptable accuracy if calcification is seen roentgenologically in the ascending aorta.

It should be mentioned with emphasis that calcifications in the aorta immediately above the sinuses of Valsalva or in the region of the obliterated ductus arteriosus are not considered since they are rarely demonstrated roentgenographically.

Most observers<sup>1,12,15</sup> have considered dilatation of the ascending aorta as the primary criterion for the diagnosis of syphilitic aortitis and considered calcification as evidence merely of arteriosclerosis. The dilatation, however, is of secondary moment when calcification is present. This is worthy of particular notice since dilatation may be confused with mere elongation of the aorta. Furthermore, moderate dilatation in the aged does not necessarily signify syphilitic aortitis. In the absence of calcification the other criteria,<sup>2,6,7,10,16,17</sup> which even in skilled hands are only moderately dependable, must be relied upon.

Many of the illustrations of syphilitic aortitis in the literature reveal calcification in the ascending aorta but its significance is not stated. Snellen<sup>14</sup> reported calcification in the ascending aorta in 7 of 8 patients who had clinical signs of aortitis but no conclusions as to its meaning are drawn. Unfortunately only an abstract of his paper was available. It is thus apparent that supporting evidence of the significance of calcification in the ascending aorta is present in the literature but that the correlation between it and syphilitic aortitis has been missed.

Since calcification is to be demonstrated, many may think that a heavy exposure using the Potter-Bucky diaphragm is the ideal technique. This, however, is erroneous since the walls of the aorta are in motion and slow exposures may obscure fine lines of calcification. Straight posteroanterior projections with rapid exposures are recommended. Any rotation toward the first oblique position may hide the right border of the ascending aorta behind the spine and adjacent structures. Confusing shadows which may be mistaken for aortic calcification are the angles of ribs, transverse processes of vertebrae, and calcifications in the bronchi. In confusing situations roentgenoscopy and oblique views are of great help. In occasional cases, one or the other of the oblique views may reveal calcification in the ascending aorta not otherwise apparent.

#### SUMMARY

The roentgenologic, pathologic and clinical findings of 66 autopsied cases of syphilitic aortitis have been reviewed. Linear calcification in the ascending portion of the aorta was present on the roentgenograms in 22.7 per cent. Comparison by roentgenologic methods has been made with 62 autopsied cases of severe arteriosclerosis of the aorta. Only 3.2 per cent in this group were found to have calcium deposits visible in the ascending aorta, on roentgenograms of the chest. The clinical findings in 20 current cases showing calcium in the ascending aorta have been presented.

## CONCLUSIONS

1. Linear calcification in the ascending aorta is a valuable roentgen sign of syphilitic aortitis.
2. When calcification in this location is present its reliability may surpass that of negative serological evidence.
3. Calcification in the ascending aorta is not an early sign of luetic aortitis and occurs most often in older, relatively quiescent cases of syphilis.

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# EGG-SHELL CALCIFICATIONS IN SILICOSIS\*

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IN RECENT years there have appeared occasional reports describing peculiar annular densities in the chest roentgenograms of men afflicted with silicosis. These are generally seen clustered in the mediastinal region as fairly large spheroid nodules averaging 1 to 2 cm. in diameter, each with a sharply demarcated, apparently calcified periphery. This appearance of a thin casing around an ovoid body led to its apt designation as "egg-shell calcification."<sup>9</sup>

Sweany *et al.*<sup>8,9</sup> in 1936 expressed the belief that these shadows represented the result of collateral tuberculosis infection in cases of silicosis. This view was based primarily on the finding, in some silicotuberculous individuals, of suggestive caseation in the postmortem sections of such peripherally calcified hilar lymph glands. The authors stated that tuberculous activation, with caseation and subsequent calcification, would advance around the margins of the glands within which the older silicotic nodules had already been formed. However, Schulte and Husten<sup>6</sup> in 1936 showed cases of silicosis in which tuberculosis was first seen to develop, in their opinion, long after the known existence roentgenologically of these nodular opacities. In addition, some of their oblique views indicated that these shadows extended into the lung fields and were not limited to the hilar glands. They did not label them as calcifications but considered them to be dense silicotic connective tissue coats around bronchi and blood vessels, the cross sections of which would be projected as annular shadows on the roentgenogram. Lommel<sup>2</sup> in 1939 demonstrated the same lesions in many cases of silicosis which he found to be uncomplicated by tuberculosis, and he too described their presence in the parenchymal portions of

the lungs. He held the view that they represented depositions of calcium in the inflammatory fibrous tissue around silicotic changes, whether in glands or in lung parenchyma. Davies<sup>1</sup> in 1939 found egg-shell or "mulberry" calcifications in great numbers among slate-quarry miners who had silicosis with or without tuberculosis. He did not, however, find them in silicotics from a neighboring coal-mining industry, even in those who had tuberculosis. Therefore he looked upon these shadows as being one peculiarity of silicosis resulting from slate-quarry mining. He made the additional observation that these lesions developed in some of the men years after they had left the mines and long before definite tuberculosis would ensue. As a result, he subscribed to the opinion that the lesions represented a degenerative process of calcification in dead or fibrotic tissue resulting from silicosis. With the aid of the tomograph, he arrived at the conclusion that they were present only in the mediastinum and not in the lung parenchyma.

In the absence of adequate postmortem studies it can readily be understood why there is such diversity of opinion regarding the nature and causation of these shadows. On the other hand, since the lesion is apparently not too uncommon, one would expect unanimity in roentgen descriptions of it, at least as regards its distribution. It is obvious that additional clinical and roentgenologic presentations are necessary if we are to develop a familiarization with and a better understanding of this rarely described roentgen finding. Four representative cases are herewith reported.

## REPORTS OF CASES

CASE I (No. 18329). J. G., a white male, aged fifty-nine, was admitted to the clinic on

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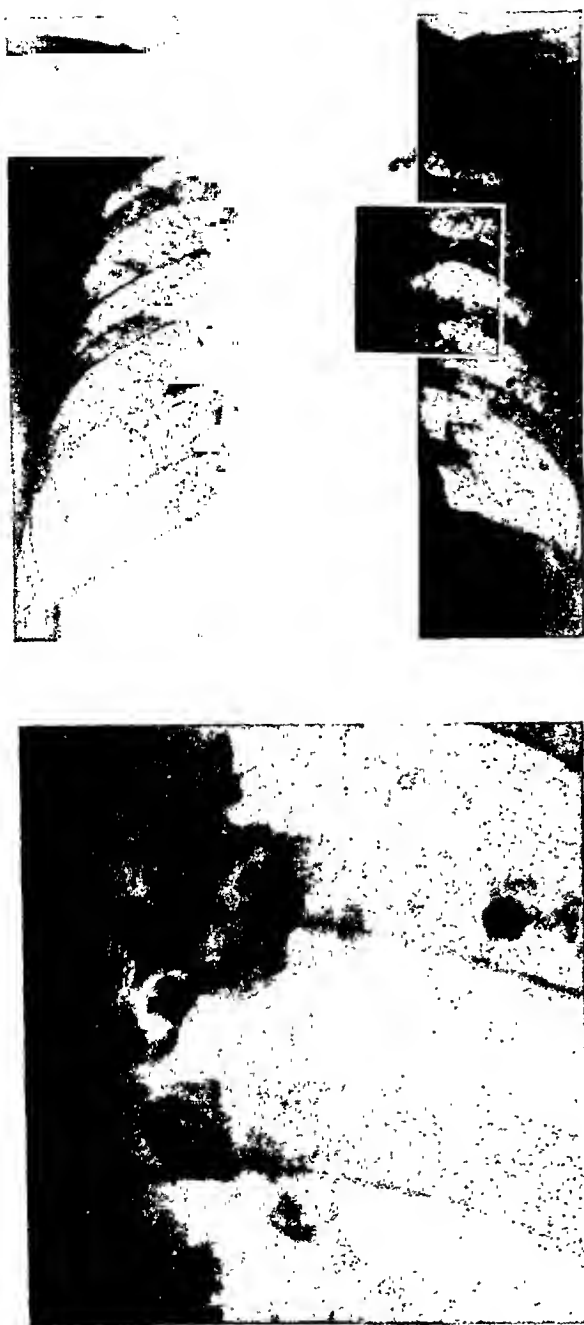


FIG. 1. Case 1. Stone-cutter for forty years. Nodulation and fibrosis of silicosis exist throughout both lungs. Densely calcified nodules, typical Gohn tubercles, are evident in the left lower and mid-lung fields. The latter, at the level of the third rib anteriorly, is included in the squared area for comparison with the larger hilar nodes which have densest calcifications at their peripheries, the so-called "egg-shell calcifications." The enlargement of the squared area, in this and in the following cases, represents an actual size contact reproduction from the roentgenogram itself.

November 30, 1942, because a chest roentgenogram, taken as part of a routine physical examination, had resulted in a diagnosis of far-advanced pulmonary tuberculosis. A study of this patient revealed no complaints or history of dyspnea, cough, hemoptysis, chest pain, fever, fatigability or weight loss. He had, however, been occupied for forty years as a stone cutter, working with pneumatic hammers and grinding lathes on sandstone, marble, limestone and lava.

Physical examination of the chest revealed only diminished resonance to percussion over both mid-lung fields. Four direct smears, one concentrated specimen, and one guinea pig culture of sputum were negative for acid-fast bacilli. The intradermal test was positive, however, with 0.1 mg. old tuberculin.

The chest roentgenogram showed the characteristic nodulation and fibrosis of silicosis in both lungs. Densely calcified nodules, typical Gohn tubercles, were found in the left lower and mid-lung fields. Of particular interest were the larger nodes in the hilum with densest calcification at their peripheries, these being the "egg-shell" lesions of the present discussion (Fig. 1).

CASE II (No. 18397). F. M., a white male, aged seventy-two, fellow-worker of Case 1, was referred to the clinic by the latter on February 2, 1943, because of the progressive development of exertional dyspnea and hacking cough over a period of one year. He too had worked as a stone-cutter over a forty-two year period, thirty years by the side of Case 1, with the same exposure to dusts of sandstone, marble, limestone and lava.

Physical examination of the chest revealed generally diminished expansion with slightly diminished resonance and scattered coarse moist râles over both upper lobes. Five direct smears and one concentrated specimen of sputum were negative for acid-fast bacilli. Intradermal test was negative with 0.1 and 1.0 mg. old tuberculin.

The roentgenogram of the chest showed bilateral fibrosis of well-advanced silicosis and, here also, egg-shell calcifications were found. In this case they appeared to extend from the hilum into the parenchyma of the right lung. Dense calcifications were also present in both apices (Fig. 2).

CASE III (No. 18946). D. M., a white male, aged sixty, fellow-worker of Cases 1 and II, was



referred to the clinic by the latter men on May 24, 1944. He had been admitted to a tuberculosis hospital one year previously with fever, cough, chest pain and a roentgen interpretation

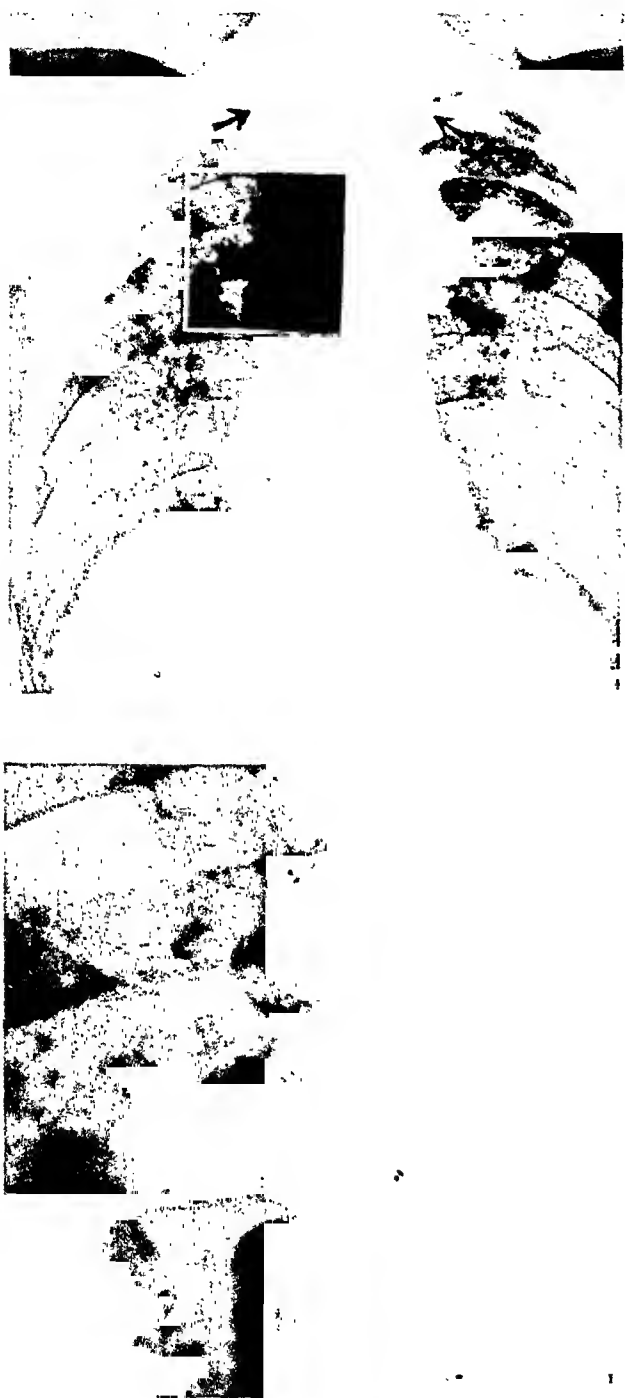


FIG. 2. Case II. Stone-cutter for forty-two years. Nodulation and fibrosis of silicosis are present in both lungs. Dense calcifications are evident in both apical areas. Egg-shell calcifications are most clearly manifest in the right hilum, but they exist also in the parenchyma of the right lung, especially between the second and third ribs anteriorly.



FIG. 3. Case III. Stone-cutter for forty-five years. Advanced nodulation and fibrosis of silicosis are evident in both lungs. There is an area of homogeneous density beneath the right clavicle. A Gohn tubercle exists in the left lower lung, and densely calcified nodules are found in both hila. Egg-shell calcifications are best seen in the left hilar area.

of active pulmonary tuberculosis. The symptoms disappeared after two weeks and never returned. During his stay in the sanatorium, sixteen direct smears and two cultures of

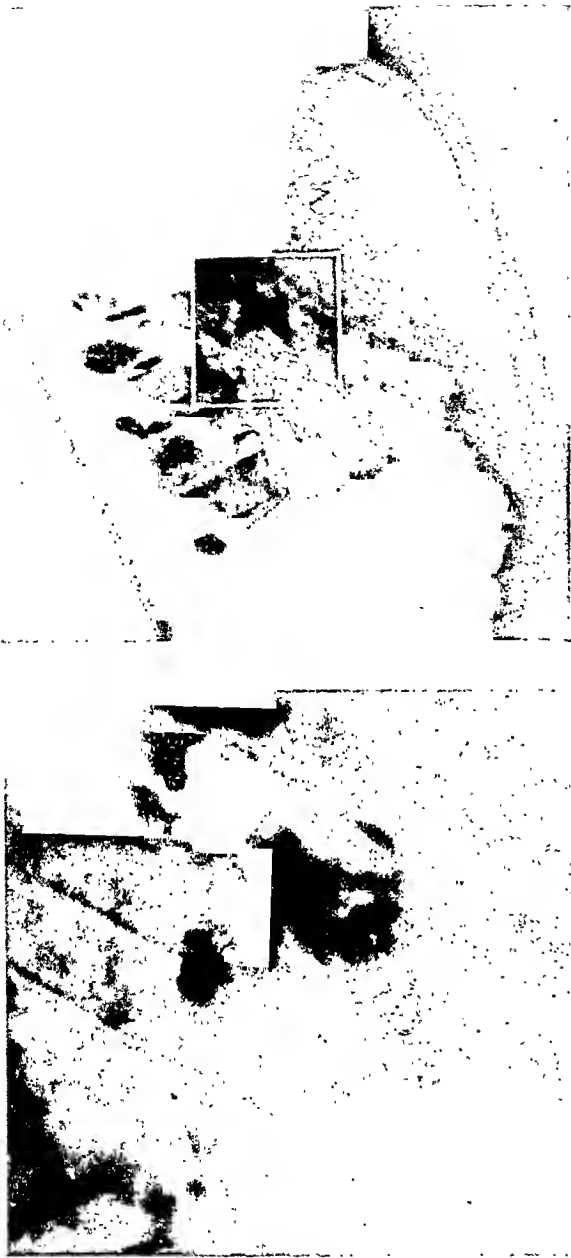


FIG. 4. Case III. Lateral view of same case as shown in Figure 3. This reveals the tendency of the egg-shell calcifications to assume a cluster formation in the hilar region. One egg-shell nodule is visible well away from the hilum.

sputum were negative for acid-fast bacilli. The Mantoux test was positive with 0.1 mg. old tuberculin. He was released from the hospital eleven months after admission with a discharge diagnosis of non-clinical silicotuberculosis. He, too, had been a stone-cutter for forty-five years, most of which time was spent by the side of Cases I and II with the same exposure to dusts of sandstone, marble, limestone and lava.

Physical examination of the chest on May, 24, 1944, revealed only bilateral upper lobe dullness.

The chest roentgenogram taken three months after admission to the hospital is reproduced herein. It showed the nodulation and fibrosis of silicosis with an area of homogeneous density beneath the right clavicle. Here again were found some typical egg-shell calcifications in the hilar regions (Fig. 3). Their cluster formation was clearly manifested on lateral view, which also showed one such shadow well away from the hilum (Fig. 4).

CASE IV (No. 17998). A. H. This patient, a white male, aged fifty-three, was admitted to the clinic on April 19, 1943, for follow-up study. He had just been discharged from a tuberculosis hospital where he had been admitted one year previously because of cough and a roentgen diagnosis of silicotuberculosis. In the hospital he had twenty-three direct smears and one guinea pig culture of sputum, all negative for acid-fast bacilli. No tuberculin test was made. He had worked as a hard-rock miner in various areas of Utah and Colorado from 1908 to 1931. His duties had consisted of digging and mill crushing for gold, copper, silver, lead and zinc.

Physical examination of the chest on April 19, 1943, revealed markedly limited expansion of both lungs, diminished resonance and coarse moist râles over both upper halves of chest, and amphoric breathing beneath the left clavicle.

A roentgenogram of the chest showed the dense fibrosis of a far advanced silicosis in both lungs with an area of markedly increased density in the left upper lobe. Clearly defined egg-shell calcifications were again encountered, not only in the hila but also in the left lung parenchyma and in the extreme right apex (Fig. 5).

During his stay in the tuberculosis hospital a routine roentgenogram of the kidney, ureter and bladder had been made because of complaints referable to the genitourinary tract, and the same egg-shell nodules were found just below the left diaphragm near the spine (Fig. 6). These were evidently within the subdiaphragmatic lymph glands which received the drainage from the lung bases by way of the afferent lymphatics which traverse the crura of the diaphragm. Apparently these glands had been affected by the same inhalation process, and with the same result, as were those which were seen in the hila of the lungs.

DISCUSSION

The above data provide clear-cut examples of egg-shell calcifications in 4 patients with advanced silicosis. In none of the men



FIG. 5. Case IV. Hard-rock miner for twenty-three years. Dense fibrosis of silicosis is seen throughout both lungs. There is an area of increased density in the left upper lobe. Many small irregular calcifications exist in both lung parenchyma. Larger and more clearly defined calcifications of the egg-shell type are present in both hilar regions. They are also evident in the left perihilar region and in the extreme right apex.



FIG. 6. Case IV. Roentgenogram of the abdomen of the same patient whose chest is shown in Figure 5. This reveals egg-shell nodules just below the left diaphragm near the spine. These are apparently within the pre-aortic lymph nodes which receive lymphatic drainage from the lung bases by way of the crura of the diaphragm.

was there any history or evidence of active pulmonary tuberculosis, although previous

primary infection could not be ruled out in all of them. Three of the cases give confirmation to the observations of Lommel<sup>2</sup> and of Schulte and Husten<sup>6</sup> that these shadows may exist within the pulmonary parenchyma as well as in the hilar glands.

As stated above, previous authors have variously theorized that the egg-shell lesions may be the calcified results of tuberculosis infection superadded to silicosis;<sup>8,9</sup> or merely silicotic densities which are not calcified;<sup>6</sup> or calcium degenerations in or around silicotic nodules.<sup>1,2</sup> To these a fourth viewpoint is herewith added, namely that the shadows may represent the results of direct inhalation of calcium along with the silica particles.

Although it is generally conceded that inhaled calcium is soluble in body fluids and is harmless to the lungs, several reports have been made which show that it can at least produce dense opacities in the pulmonary roentgenogram. Rest<sup>1</sup> has recently presented an interesting case with a temporary miliary mottling of the lung fields due to the inhalation of finely ground calcium carbonate. Rogers,<sup>5</sup> in his observations of silicosis among the marble workers of Vermont, found large numbers of calcified nodules in the hilum and scattered throughout the lungs. He attributed them to the inhalation of calcium dust. He did not, however, present any reproductions of roentgenograms of this finding. Siegal, Smith and Greenburg,<sup>7</sup> in their studies of tremolite talc miners, demonstrated large calcified plaques on the visceral pleura and suggested that they might have resulted from the deposition of inhaled calcium already present in the dust.

Lumsden and Dearing,<sup>3</sup> in an extensive tuberculosis survey, found pulmonary calcification on roentgen examination to be thirty to forty times as high in areas which had limestone and chert underlying the topsoil as in areas which lacked such soil. They also showed a lack of correlation between those calcifications and tuberculin sensitivity. Such importance of environment

must be given consideration when analyzing Davies' finding of egg-shell calcifications among slate workers and not among coal miners; it is interesting to note that Davies found 1 per cent lime in his analysis of the slate dust.<sup>1</sup> Although no chemical analyses of the inhaled dust were made in the cases described in the present paper, there might be some significance in the fact that 3 of these 4 cases represented men who had worked side by side as stone-cutters for many years, with considerable exposure to the calcium dusts of marble and limestone as well as to that of sandstone.

Final conclusions cannot be drawn, however, from such considerations alone. Actually the exact nature of egg-shell calcifications could be determined only by extensive chemical and pathological studies which have never been made as yet. Meanwhile it will be necessary for the physician who may encounter such opacities to bear in mind all of the above discussed possible explanations for them. With him will rest the responsibility for making the important decision, in the case of a given patient, as to whether the shadows in question do or do not represent lesions of a complicating tuberculosis infection.

#### SUMMARY

(1) Four cases of silicosis with sharply demarcated annular densities in the roentgenograms of the chest, so-called "egg-shell calcifications," are herein presented and the roentgenograms reproduced.

(2) The few authors who have hitherto reported on such shadows have differed in their statements regarding the distribution of them in the pulmonary roentgenogram. Some have stated that they exist only in the hilar areas; others have described their presence in the lung parenchyma as well. The cases in this report appear to confirm the latter view.

(3) The previous authors have also differed in their interpretations of the cause of these shadows. They have variously labeled them as being (a) calcified tubercu-

lous lesions, (b) uncalcified silicotic densities, and (c) calcium degenerations in or around silicotic nodules.

(4) To these a fourth viewpoint is now added: that the densities under discussion may represent the results of inhalation of calcium along with the silica particles.

(5) In the absence of definite knowledge of the cause of egg-shell calcifications, the clinician and roentgenologist who encounter them are placed in the difficult position of deciding whether they represent a complicating tuberculosis infection or a less serious condition.

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# CALCIFIED HEMANGIOMAS OF THE LIVER

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**H**EMANGIOMAS of the liver, among the most common benign tumors of the viscera, are rarely diagnosed prior to surgical or pathological discovery. They seldom become calcified and infrequently grow large enough to produce pressure symptoms. When symptoms of pressure or bleeding occur, other possible diagnoses are usually given first consideration.

The following case is of interest in that calcification, characteristic of hemangiomas as seen elsewhere in the body, was present in the liver and allowed a tentative diagnosis to be made.

## REPORT OF CASE

The patient, housewife, white, aged sixty-eight, entered the hospital on February 12,



FIG. 1. Appearance of hemangiomas at gastrointestinal examination.

1944, with complaint of pain in the left lower chest and adjacent abdomen. Patient had had the "flu" during early part of December, 1943, and just prior to Christmas began to have pain of a sharp, burning or stabbing character, which was periodic in nature. A physician taped her chest but no relief was gained. During this time she began to perspire quite freely and her pain was so intense that she walked the floor at

night in an effort to gain relief. On her admission to the hospital, the pain was of the same character and intensity, and even pressure of bed clothes added to her discomfort. The pain was localized low in the back and to the right of midline. Entrance temperature, 101° F., pulse 86 with occasional dropped beat, blood pressure 190/112, respiration 20 and regular, height 5 feet, weight 100 pounds. Physical examination was negative except for the abdomen. The liver was questionably palpable. Tenderness was found along the distribution of the lower left thoracic intercostal nerves and in the upper abdomen. Tenderness of the costovertebral angle was evident on the left. Reflexes were physiological with adequate circulation.

*Past History.* Patient was a para vi, gravida vi. She passed through the menopause in 1928 and since then has had no bleeding or discharge. Since about the middle of 1942, she began to note swelling of the feet and ankles towards the end of the day, which receded after a night's sleep. No dyspnea.

Urine was essentially negative except for 15 to 20 blood cells. Complete blood count taken on February 13 showed: erythrocytes, 4,310,000; hemoglobin, 83 per cent, 12.5 gm.; leukocytes, 14,400; granulocytes, 87 per cent; small lymphocytes, 12 per cent; large lymphocytes, 0; monocytes, 1 per cent.

Roentgen examination of the thoracic spine on February 14, 1944, revealed osteoarthritic changes in the thoracic spine with sclerosis of the aorta. On February 17, roentgen examination of the stomach revealed no pathologic condition of the heart, lungs, stomach or duodenum. There were, however, extensive circumscribed calcified shadows in the region of the liver (Fig. 1) in which streaks of calcification seemed to radiate out from the center. The impression at this time was that of benign neoplastic involvement of the liver, possibly hemangiomas.

The patient's course in the hospital was uneventful, other than her temperature, which was spiking in character, in which the highest was 101° F. On February 23 she had a chill and her temperature went up to 103.8° F. The stools, during the hospital stay, were always of a brownish color. On February 14, a sedimentation rate was done, which in fifteen minutes was

16 mm. and forty-five minutes, 53 mm., and on February 24, a catheterized urine specimen showed 2 to 3 pus cells, and 2 plus albumin.

The patient was discharged home on February 26, 1944, and at that time still complained of pain in her lower left side.

She was readmitted on March 12, 1944, with same history, except that the pain had become more diffusely spread over into the right upper abdomen.

*Physical Findings.* Blood pressure, 140/96; temperature, 101.4° F.; pulse, 90; respirations, 38; heart and lungs, negative.

*Abdominal Examination.* Liver was not pal-

The principal autopsy findings in detail were:

(1) An enlarged, irregularly outlined liver that extended approximately 6 cm. below the ribs in the midaxillary line. The right lobe of the liver had a mottled and dark purple color. The central portion of this lobe was replaced by one slightly raised nodular area of dark purple color. Many smaller diffuse areas were found beneath the capsule and were irregularly scattered within both lobes. The largest nodule measured 12 by 6 cm. and the smallest measured 5 cm. in diameter. These masses were quite sharply demarcated from a comparatively normal appearing liver parenchyma. None of



FIG. 2. Gross specimen at autopsy.

pable as on previous examination. Some tenderness was evident in both costovertebral angles. Abdomen was negative for masses and only voluntary muscle guarding was present in the upper abdomen. A slight amount of tenderness was found.

Urine specimen on March 13 was pinkish in color, negative for occult blood with occasional pus cells.

On March 15, 1944, at 6:05, patient called the nurse because of sudden onset of pain in the right upper abdomen and vomited approximately a cupful of bright red blood. The patient was extremely pale, lips cyanotic, radial pulse weak, respirations slow. At 6:42 the patient died.

Postmortem examination by Dr. Robert Stier revealed the cause of death to be a ruptured dissecting aneurysm of the aorta just above the diaphragm. Multiple cavernous hemangiomas were found in the liver.

the major blood vessels was involved by the above mentioned tumor masses. The nodules cut with little resistance, but within the masses, particularly the largest mass, some pin point areas were encountered that cut with bone-like resistance (Fig. 2 and 3).

Other abdominal organs showed no remarkable changes.

(2) Within the chest cavity the lower segment of the thoracic aorta showed a fusiform dilatation that had ruptured and the right thoracic cavity contained coagulated blood. The lower right lung was attached to the aneurysm and the adjacent lung tissues were hemorrhagic. The lungs otherwise except for emphysema and congestion showed nothing remarkable. The heart was unaltered. The aorta showed calcified plaques, more numerous as the thoracic portion and aneurysm were reached.

On microscopical examination (Fig. 4 and 5), the tumor masses of the liver were seen to be





FIG. 3. Roentgen examination of specimen.

made up of cavernous sinuses that occasionally showed obliteration by hyalinized connective tissue in which some deposits of calcium salts were noted. The tumor masses were not encapsulated and some isolated blood sinuses were found in the surrounding liver parenchyma. The sinuses were lined by single rows of uniformly equal endothelial cells and in none of the sections was there any evidence of activity among these lining cells. The liver cells showed autolysis and atrophy. Numerous deposits of normal appearing fat were noted, both extra- and intracellularly. The lungs in the region of the ruptured aneurysm showed marked infiltration by autolyzed red blood cells. Apparently no hemangiomas were present here.

Angiomas of the liver are practically always of the cavernous type. According to

Geschickter and Keasbey,<sup>15</sup> blood vessel tumors are perhaps as common as any form of neoplasm occurring in the body, and an extremely large number (109 out of 570 tumors of this type listed at the Johns Hopkins Hospital) occurred in the liver. The majority of these tumors were small, 0.5 to 5 cm. in diameter, and were accidentally discovered at autopsy. Occasionally they grow to such size that they become clinical problems by producing pressure symptoms. The usual diagnoses in these instances are cyst or neoplasm of the pancreas, cyst of the omentum or mesentery, or metastatic carcinoma of the liver. In one instance the tumor grew so large that it weighed 18,160 grams, or 39.6

pounds, at autopsy (Ray).<sup>35</sup> Angiomas occasionally bleed following trauma. Kissinger<sup>25</sup> reported a case of an infant with death from rupture of a cavernous hemangioma following a difficult labor.

The roentgen appearance of calcified hemangiomas was recognized by Ruggles<sup>40</sup> in 1919 following examination of an obvious angioma in the soft tissues of the jaw. Prior to this (1916, American Atlas of Stereoroentgenology) he had reported a case of undiagnosed soft tissue calcification in the forearm. These occurred as numerous calcified masses varying in size from 1 to 10 mm., without definite reference to the structures of the arm. Some of the large ones showed a cyst-like structure with a calcified nucleus. When the nature of these various calcifications became evident, Ruggles predicted their recognition in liver and intestines.

Carman,<sup>8</sup> in 1921, observed a polypoid mass in the duodenum without calcifica-

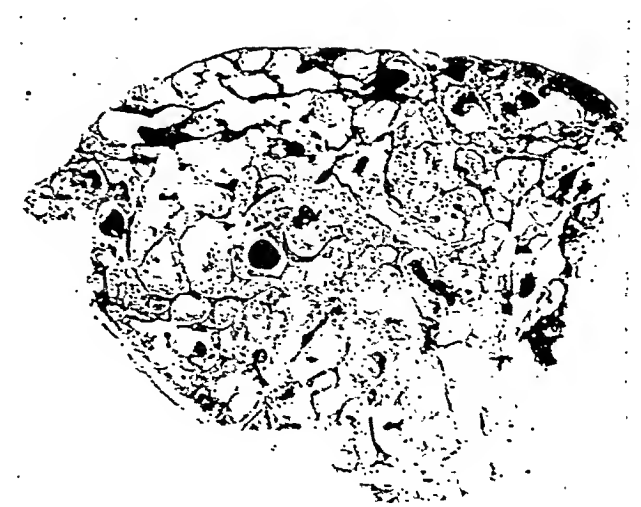


FIG. 4. Low power photomicrograph.

tion, which on operation was found to be a hemangioma. His examination of the literature at this time revealed a case reported by Winternitz and Boggs<sup>51</sup> in 1910, detailing the necropsy findings of multiple hemangio-endotheliomas throughout the

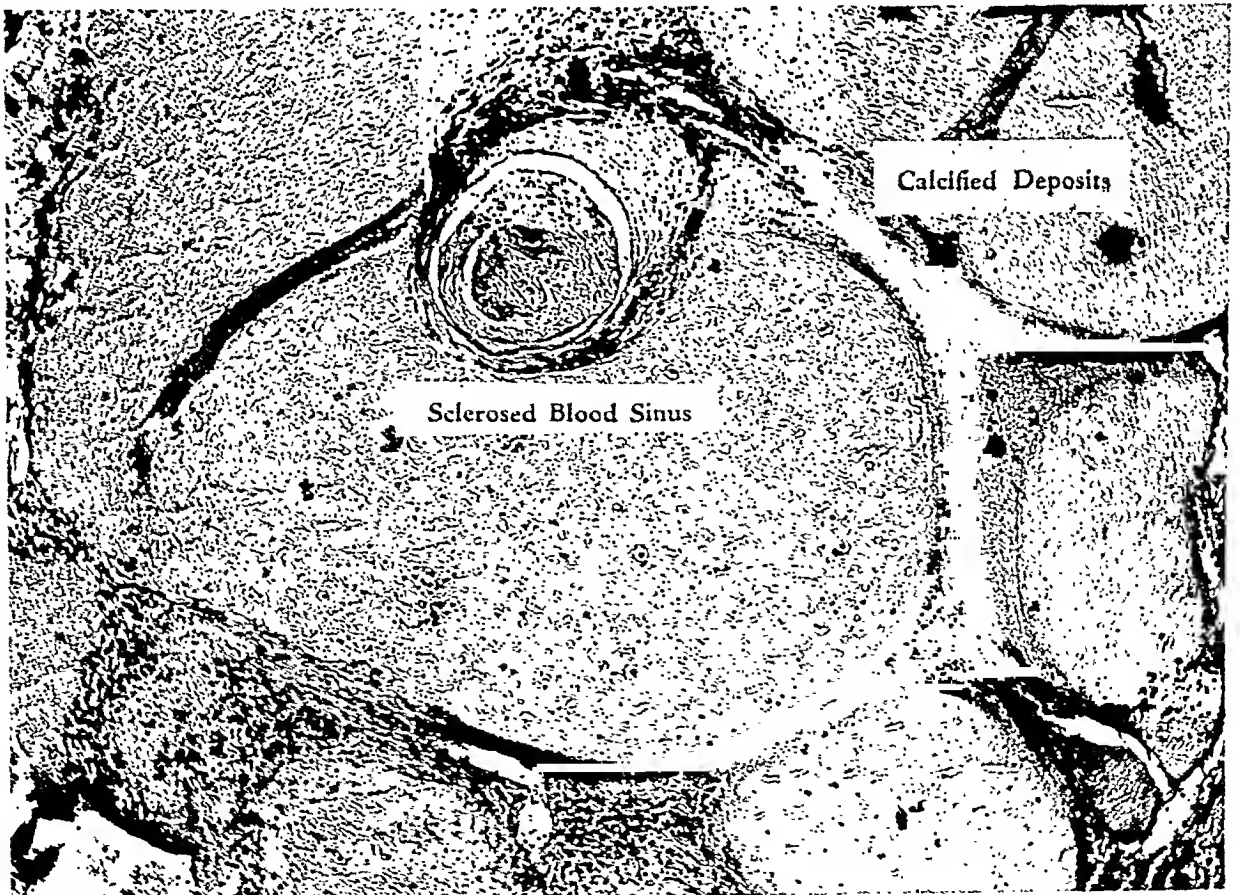


FIG. 5. High power photomicrograph.

alimentary tract. In 1924 Moore<sup>29</sup> reported 23 cases of benign tumors of the stomach, 5 of which were hemangiomas. No diagnostic findings were observed which would serve to differentiate hemangiomas from other benign tumors. Several of the hemangiomas were reported as carcinoma of the stomach. Hemangiomas of the kidneys have occasionally been reported (MacKenzie and Hawthorne<sup>27</sup>), and in none of these cases has calcification been present to allow a preoperative diagnosis; nor has there been anything in the history, symptoms or findings that would make a positive diagnosis of angiomas possible.

In 1930 Bucy and Capp<sup>6</sup> gave a complete description of hemangiomas occurring in bone. According to them, the appearance of hemangioma cavernosum of a flat bone is characteristic of the lesion. There are strikingly large, numerous "sunburst" trabeculations arising and radiating out from a common center. In some of the cases the trabeculations have the appearance of fine bone spicules. These writers made the lucid observation that the changes in bone, i.e., destruction and spiculization, are merely the reaction of the bone to the hemangiomatous growth. To illustrate the point, a case is described of a hemangioma arising in the meninges and invading the parietal bone. Microscopically, however, the same osseous changes of absorption and osteogenesis can be seen as in cases of true hemangiomas of bone. This would seem to indicate that these changes are the result of the ingrowth of the hemangioma into the bone regardless of its origin, and that they are not characteristic of hemangiomas arising in bone. The radiating calcification of the hemangioma of the liver found in this case further substantiates this point. The same tendency was strikingly brought out by Schwartz<sup>44</sup> in 1939, and it was his description of hemangiomas of the skull that led me to the belief that the liver lesion might be due to benign tumors of this type.

Ponzio<sup>34</sup> in 1932 observed numerous mulberry-shaped calcium shadows, up to the size of chick-peas, in the regions of the liver

and spleen and concluded that these shadows were calcified hemangiomas or lymphangiomas. The diagnosis was made because of the similarity of the calcified shadows to those described by Ruggles in angiomas elsewhere, but confirmation is, unfortunately, lacking.

In the differential diagnosis of calcification in the liver, gummata, hydatid cysts, tuberculomas, amebic abscesses, intrahepatic calculi, calcified primary and metastatic carcinomas and calcified subphrenic abscesses have been considered. In most of these, the character and location of the calcification serve to differentiate them from hemangiomas.

Gummas, as a rule, do not exhibit calcification. Henke and Lubarsch, however (Gray<sup>17</sup>), stated that calcium may be deposited in these lesions. The lesions would probably be of long duration and evidence of syphilis should be present elsewhere in the body. The calcification, although it may be trabecular in type, would probably not exhibit the radiating tendency seen in hemangiomas.

In echinococcus cyst, the masses are usually in the form of mild, negative shadows because of the greater roentgen permeability of the cysts as compared to the surrounding structures. The masses may have the same density as the liver. The shadow is usually rounded and if located near the superior or posterior aspect of the liver it may be demonstrated by simple roentgen examination. If the cysts become infected or ruptured, they may contain air with a fluid level.<sup>3,16,21,34,35</sup> In chronic cases, calcification may occur which usually assumes a shell-like area with calcareous concentric strips alternating with transparent ones (Cottone<sup>9</sup>).

Calcified tuberculomas differ in their structural characteristics. The appearance varies with the age of the lesion and early there is calcification of the capsule surrounding the central core (Sweany<sup>16</sup>). Later on, there is the appearance of a sphere with a central density having a surrounding moat. The size may reach that of a marble

(smaller than the hemangiomata seen here) and there is usually evidence of tuberculosis elsewhere in the form of calcified glands or an active lesion.

The acute amebic abscesses give a clinical picture similar to subphrenic and intrahepatic abscesses without the presence of calcification. In the chronic cases, calcification occurs in the form of dense irregular shadows which are quite different from those seen in hemangioma. In these cases, there has practically always been a history of amebic dysentery (Santoro<sup>42</sup>; Dickinson<sup>10</sup>).

Single or multiple intrahepatic calculi are exceedingly rare. The appearance as described by Volpe<sup>49</sup> is that of a mulberry-like shadow in the region of the liver. Calcified subphrenic abscesses can be differentiated easily by location. Calcified primary carcinoma has been reported by Hamburger<sup>19</sup> occurring in a five year old child. He ascribed the calcification to irradiation of the tumor. In his article he states that calcification may also occur in the liver in the later stages of infective granuloma, general metabolic diseases (chronic kidney diseases or conditions resulting in the destruction of bone) eclampsia and diabetes. Calcified metastatic carcinoma is rarely seen, although, because of the marked influence of various endocrine agents, we may see calcified metastases more commonly in the future. The clinical picture should serve to differentiate these conditions.

The treatment of hemangiomas is either by surgery, radiation therapy or a combination of these two. Surgical procedures are simplified if the growths have a pedicle (Morris,<sup>30</sup> Peck,<sup>33</sup> Morton,<sup>31</sup> Shumacker<sup>13</sup>). Serious complications, such as fatal hemorrhage, have occurred due to rupture prior to or at laparotomy. The excision must be made wide of the growth as hemorrhage, even from a needle prick, may be uncontrollable (Tinker<sup>17</sup>). Tinker states that in the light of newer surgical methods, particularly electrosurgery, surgeons could be bolder in attacking hepatic tumors. In the

field of radiation therapy, Ray<sup>38</sup> described his successful results in an inoperable case. A large spheroidal, inoperable hemangioma was found deeply embedded in liver substance. Four Cushing silver clips were pressed into the liver substance at intervals about the margin of the tumor. A course of roentgen therapy was instituted shortly afterwards, alternating anterior and posterior fields with average dosages of 300 to 370 roentgens. Over a period of four months 5,772 r was administered and the series was repeated to 4,602 r after an interval of four months. Observation indicates an absence of symptoms since treatment and successive roentgenograms of the abdomen have revealed a marked and progressive diminution in the size of the tumor. This has continued three to five years after cessation of all treatment. Morris<sup>30</sup> gave irradiation to hemangiomas of the liver in a case in which he had successfully removed the major hemangioma. One month after operation a mass the size of a fist was found over the right lobe and it was thought that this represented active growths of hemangiomas noted on the right dome of the liver at the time of operation. Eight treatments of  $\frac{1}{3}$  erythema dose were given during the next month, and when last seen three years later, no masses were palpable and the patient was symptom free. These two experiences, in view of the known response of hemangioma to irradiation elsewhere in the body, would indicate that radiation therapy offers a valuable adjunct to treatment, particularly in the inoperable cases.

#### SUMMARY

The tendency towards radiation of calcified spicules from a central point which is seen in hemangioma of flat bones (Bucy and Capp) is also seen in this case of hemangiomas of the liver. This may prove to be characteristic of calcification in visceral hemangiomas. Radiation therapy is indicated in certain of these lesions.

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# ROENTGEN DEMONSTRATION OF THE SEMILUNAR CARTILAGES OF THE KNEE

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## INTRODUCTION

THE purpose of this paper is to present a roentgen technique for the demonstration of the semilunar cartilages of the knee joint. The method to be described results in an adequate visualization of injuries of these cartilages and materially aids in their correct diagnosis and treatment.

In the clinical examination of the knee for suspected injury to the menisci the usual roentgen studies have been made either to rule out pathologic conditions which might give rise to symptoms similar to those of cartilage injuries or for their negative value.<sup>15,16,17</sup> On these roentgenograms of the knee the semilunar cartilages are not visualized except in those instances in which (1) the cartilages are calcified,<sup>3</sup> or when (2) air is present in the knee joint spontaneously.<sup>8,12,14</sup> Both of these findings are unusual. We have seen one case of a calcified lateral meniscus and several instances of the spontaneous presence of air in the knee joint.

The following roentgen signs have been suggested as being indicative of injuries to the semilunar cartilages:

- (1) Narrowing of the joint space on the side of the injured cartilage.
- (2) Slight lateral displacement of the femoral condyle on the side of the injury.
- (3) A localized sclerosis of the tibial tuberosity just beneath the involved cartilage in comparison to the normal.<sup>8</sup>

None of these signs, however, have been proved to be of sufficient accuracy to be of value in the diagnosis.<sup>13</sup>

In order to visualize the menisci roentgenographically, contrast media, radiolucent (gas, usually air) or opaque (iopax, sodium iodide), singly or in combination, have been injected into the knee joint.<sup>1,4,6,10,18,21,22</sup> In addition, the cartilages have been demonstrated without the aid of contrast media by forced abduction of the knee joint.<sup>7,8,9,20</sup> In one series of normal knees,<sup>20</sup> the medial meniscus was visualized in 70 per cent of the cases. However, the lateral meniscus was only visualized in 2 out of 30 cases.

By combining the injection of a small amount of air with forced abduction of the knee joint during roentgenography, we have been able to visualize both semilunar cartilages satisfactorily.

## TECHNIQUE

1. *Injection of Air into Joint.* The entire examination is conducted in the roentgenographic room. No special preparation has been employed. Most of our patients have had the examination directly after reporting to the roentgen room from their usual duties. The patient is placed on the roentgenographic table in the supine position with his legs hanging down over one end of the table. The skin over the lateral aspect of the knee joint is surgically prepared. The site chosen for injection is just lateral to the patellar ligament at the knee joint through the ligamentum mucosum.<sup>22</sup> The skin and superficial subcutaneous tissues are infiltrated with 1 per cent novocain. The anesthesia is purposely not carried down to the joint capsule, because when the joint capsule is pierced, the patient experiences a sudden, momentary pain which we have used as an indication that the needle is in



the joint space. (In the last group of cases, novocain has not been employed. It is planned to discontinue its use in order to simplify the technique and eliminate possible sources of reaction and contamination.)

A No. 20 gauge needle attached to a 30 cc. syringe is used to enter the joint. If fluid is present, *as much as possible is aspirated*. This is facilitated by pressure on the suprapatellar pouch. After the fluid is aspirated, 10 to 20 cc. of atmospheric air (depending on the size of the knee joint), filtered through several thicknesses of sterile gauze, is slowly injected into the joint. *If the needle is in the joint, the air can be injected with very light pressure on the piston of the syringe.* If greater pressure is necessary, it means the needle is not in the free joint space. While the air is being injected, the suprapatellar pouch may be seen to bulge slightly along the medial aspect of the joint, but this may not occur in knees with large joint spaces. After the air is injected, the needle is withdrawn and the puncture wound sealed with collodion. In none of our cases has there been any extra-articular leakage of air as far as we could determine from the roentgenograms or by clinical examination.

2. *Accessories Needed for the Technique Used.* In order to carry out the technique of roentgenography about to be described, we have had to construct two simple additions to our roentgenographic equipment.

a. A device for immobilizing the knee joint while lateral traction is exerted on the leg and thigh. We have used an L shaped piece of wood constructed of 2 by 4 inch lumber. The vertical portion of this device is 6 inches high. A 5 inch roller bandage about 2 inches in diameter is fastened to the external surface of this vertical piece by means of gauze and adhesive. The free end of the horizontal piece must be constructed so that it can be secured to one side of the table. This will vary with tables of different types. The length of the entire bar with the roller bandage is such that when the device

is fastened to the side of the table and a knee placed against the roller bandage, the knee will automatically be centered on the table (Fig. 1a).

b. A device for exerting lateral traction on the thigh. This was made from unbleached muslin (three thicknesses) 60 inches long and 8 inches wide, one end of which was made into a loop 12 inches in diameter. The other end of this muslin band was so altered that it could be incorporated into the mechanical portion of the compression band device, which is present on most roentgenographic tables (Fig. 1b).

3. *Technique of Manipulation and Roentgenography, Including the Effect of Fluid.* After the air is injected, the patient is placed in the prone position on the table. The looped end of the muslin band is slipped over the foot and leg on to the thigh. The L shaped piece of wood is fastened to the side of the table and the knee joint placed against the roller bandage. The free end of the muslin band is incorporated into the mechanical portion of the compression device and then is tightened so that lateral traction is exerted on the thigh to the limit of the patient's tolerance. Manual traction on the leg is produced by hand, again to the limit of the patient's tolerance (Fig. 1c).

By the maneuver outlined above one compartment of the knee joint is "opened up" and a "condition of pressure" is produced therein which seems to "suck" the air previously injected into the joint to the side being forcibly abducted. By making the roentgen exposure while this lateral traction is being performed, the semilunar cartilage on this side of the joint is visualized. To visualize the cartilage in the other compartment of the knee, the traction and knee immobilizing devices are switched to the opposite side of the table and the same procedure as outlined above is repeated.

Both compartments of the knee joint, medial and lateral, are examined in the prone and supine positions. Since air will rise to the highest level, by roentgenograph-

ing each compartment of the joint in both positions, the anterior horn (when the patient is supine) and the posterior horn (when the patient is prone) of each meniscus will be visualized. The lateral horn is visualized in each position.

remains behind. When the patient is prone this fluid gravitates into the most dependent portion of the joint cavity, the anterior suprapatellar extension, and thus most of it is removed from the region of the menisci and allows their visualization (Fig. 2a).

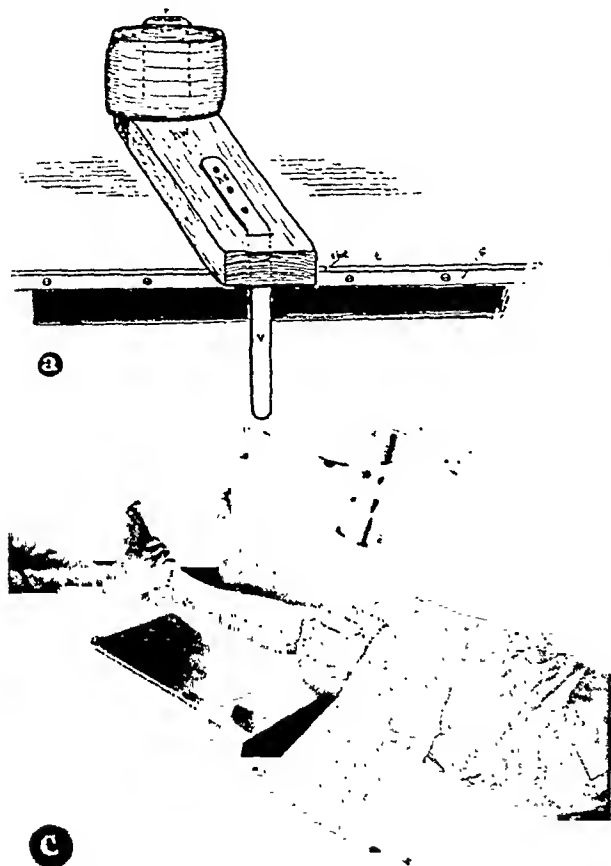


FIG. 1. *a*, sketch of knee immobilizing device, to show construction and method of fixation to table top. A steel bar is bent at right angles. The horizontal arm of this bar (*hw*) is fastened to the horizontal portion of the wooden  $\perp$  (*hw*). The vertical portion of the steel bar (*v*) passes through a slot in *hw*. It then fits into a slot running along the edge of the table between the table top (*t*) and a steel edge (*s*). The roller bandage (*r*) is secured to the vertical portion of  $\perp$  by a gauze binder.

*b*, sketch showing the construction of thigh traction device. The looped end (*l*) fits around the thigh. The opposite end has a small loop to receive a steel pin (*p*). This pin

fits into the mechanical fixation device (*m*) of the compression band which is an accessory provided with most roentgen tables. (*s*) is the slot into which the steel pin fits.

*c*, photograph showing complete set-up at the time of roentgenography. The cone is not extended in the photograph for purposes of illustration. Actually it is extended so it is in contact with the knee. The knee immobilizing device is different than shown in *a*; however, the type shown in *a* is better and more rigid due to the added horizontal steel arm (*hw*). The table is in a  $20^\circ$  Trendelenburg position.

(The construction of these devices will vary with different types of tables. The above are described in detail because they are suitable for many roentgen tables in military use.)

It is difficult to remove all of the fluid in a knee joint on aspiration. In this series of cases it has been found that fluid is frequently present in those knees with fractured menisci. This fluid cannot be detected clinically or by the usual roentgenograms but it interferes with adequate visualization by pneumography. Even though all the fluid possible is aspirated some apparently

However, a frothy appearance frequently results, which hinders accurate interpretation (Fig. 3d). Posteriorly the synovial cavity is limited in extent and is confined to the region of the joint. When the patient is supine any fluid in the joint will gravitate to this portion of the joint, which is the most dependent, and prevent visualization of the menisci. To overcome these effects of

the fluid, the following routine of positioning is employed:

(1) Following the injection of air into the joint the patient is placed in the prone horizontal position for five minutes to allow any fluid present to gravitate to the anterior compartment of the joint.

tained during, in between and after the time these roentgenograms are made.

(4) Following the taking of the roentgenograms in the prone position, the patient assumes the supine posture while the table is still in the Trendelenburg position. This keeps the fluid in the anterior supra-

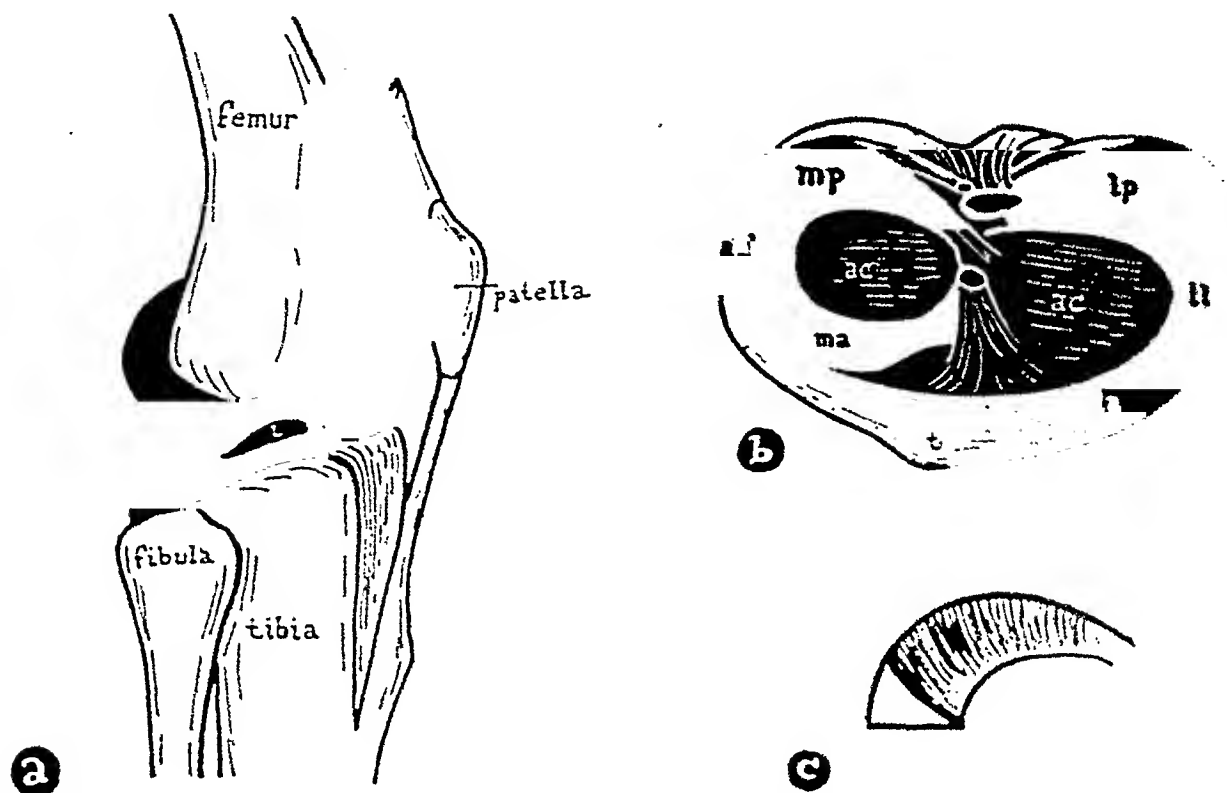


FIG. 2. *a*, drawing of knee joint region (lateral view) to show the extent and distribution of the synovial cavity of the knee joint (blackened area). It is shown distended. (*b*) represents the lateral meniscus. Note the large suprapatellar extension of the joint cavity anteriorly. Posteriorly the joint space is more limited in extent and confined to the joint region.

*b*, drawing to show the shape of the semilunar cartilages of the knee (blackened areas) as seen by looking down on the articular surface (*ac*) of the tibia. (*m*) refers to the medial meniscus and (*l*) to the lateral meniscus. (*p*), (*a*) and (*l*) refer to the posterior, anterior and lateral horns of each meniscus. (*t*) is the tibial tubercle (anterior). The menisci are drawn as shown in standard anatomical texts.

*c*, a sketch illustrating a section through the lateral horn of a semilunar cartilage to show the wedge shape.

(2) While this position is maintained, the patient's leg is elevated as much as possible for about three minutes to allow the fluid to gravitate into the suprapatellar extension of the joint cavity.

(3) The table is then put in the 20 to 25 degree Trendelenburg position and the elevated leg is brought down to this level. The first set of roentgenograms are then taken. The Trendelenburg position is main-

patellar extension of the joint cavity. The set of roentgenograms with the patient supine are then taken. It may be necessary to increase the tilt to 35 degrees in this position. The roentgen tube is always kept parallel with the table top.

Using the technique outlined, we have been able to visualize the cartilages with a small amount of air, 10 to 20 cc., compared with the large amounts (100 to 140 cc.)

previously used. With these large amounts, most of the air is in the suprapatellar pouch. Recently it has been suggested<sup>6</sup> that a binder be put on the knee to obliterate this pouch and thus allow use of less air. We believe tilting is more satisfactory since it also takes care of any fluid remaining in the joint.

Most tables will tilt in one direction only. By switching the traction and immobilizing devices from one side of the table to the

tension cone, the lower edge of which is in contact with the knee.

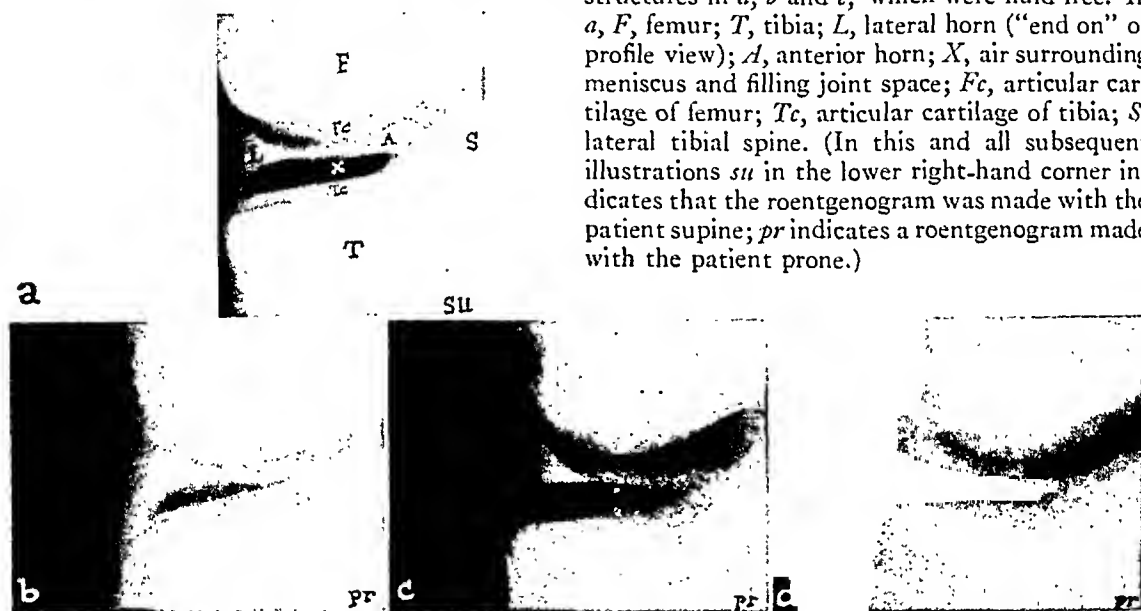
Following the examination the patient is allowed to resume his usual activities except for strenuous leg exercises, which are usually advised against for five days. The air is absorbed in about five to seven days.

#### INTERPRETATION OF ROENTGEN FINDINGS

##### 1. *Roentgen Appearance of the Normal Semilunar Cartilages or Menisci.* The follow-

FIG. 3. The roentgen appearance of the normal lateral meniscus. In *d* there was a small amount of fluid in the joint. This produced a frothy appearance compared to the sharp outlines of the joint structures in *a*, *b* and *c*, which were fluid free.

In *a*, *F*, femur; *T*, tibia; *L*, lateral horn ("end on" or profile view); *A*, anterior horn; *X*, air surrounding meniscus and filling joint space; *Fc*, articular cartilage of femur; *Tc*, articular cartilage of tibia; *S*, lateral tibial spine. (In this and all subsequent illustrations *su* in the lower right-hand corner indicates that the roentgenogram was made with the patient supine; *pr* indicates a roentgenogram made with the patient prone.)



other, both compartments of the knee joint can be visualized in the Trendelenburg position.

In the prone position the patella, being in contact with the table, frequently is pushed over the joint spaces or prevents true posteroanterior positioning. To overcome this, the thigh is elevated about 1½ inches so that the patella is no longer in contact with the table top. The foot is always positioned so that it extends over one end of the table. This facilitates manual traction. The individual who exerts manual traction is only allowed to do this on two occasions. He is further protected by a leaded rubber apron and the use of an ex-

isting brief description of the anatomy of the menisci is given to correlate their gross and roentgen appearance (Fig. 2, *b* and *c*).

The menisci are fibrocartilaginous wedges in the knee joint interposed between the femur above and the tibia below. There are two menisci, a medial and a lateral. Each meniscus is roughly part of a circle in outline.

The superior surface of each meniscus is concave, the inferior surface flat. On cross section they appear wedge shaped. The peripheral border of each cartilage is thick and attached to the capsule of the joint. The internal margin is thin and free of attachments.

For purposes of description, the menisci may be divided into anterior, posterior and lateral horns.

The lateral meniscus is nearly completely circular in outline. The individual horns are approximately similar in size and shape and contribute equally to the structure of the entire meniscus.

The medial semilunar cartilage is nearly semicircular in form (sickle shaped). The posterior horn and adjacent portion of the lateral horn is broader than the anterior horn and adjacent portion of the lateral horn. (These descriptions of the anatomy are from standard anatomical texts. We have not had the opportunity to examine a series of specimens.)

On the roentgenogram the lateral meniscus appears as a band of increased density, in contrast to the air above and below it, extending across the lateral compartment of the joint from the capsule laterally to the tibial spines medially (Fig. 3). For purposes of description it can be divided into two portions, a lateral one-fourth and a medial three-fourths. The lateral portion represents an "end on view" of the lateral horn and appears as a triangular or wedge shaped area of increased density with its apex pointed medially and extending for 10 to 12 mm. into the joint from its lateral capsular attachment. Its density is greater than the remaining portion of the meniscus (with one exception) because it is an "end on view."

The medial three-fourths of the meniscus is a band of fairly uniform width (4 to 6 mm.), blending with the density of the lateral horn and extending medially across the joint compartment to the region of the tibial spines. Its density is less than that of the lateral horn and is approximately equal to that of the articular cartilages. It represents either the anterior or posterior horn of the cartilage, depending on how the roentgenogram was made. Along its inferior margin is a fine threadlike line of increased density (0.5 mm. thick) which extends to blend with the density of the lateral horn. The opacity of this line approaches that of

the lateral horn. It represents the widest portion of the anterior or posterior horns, that is the base. Its medial extent varies but it can be followed for about 1.5 to 2 cm. from the lateral horn. It can only be seen on roentgenograms of fine detail.

The articular cartilage of the femur and tibia is clearly visible. The width of the articular cartilage varies from 3 to 5 mm. Medially the cruciate ligament can usually be seen either in part or in its entirety. It appears as a band of uniform increased density, about 1 to 1.5 cm. wide, extending from the femur above (the intercondyloid regions) to the tibial spines below. Its density approximates that of the "end on view" of the lateral horn of the meniscus. Its borders are sharp and straight.

This appearance is fairly constant in the normal, in both supine and prone roentgenograms, there being little difference in the anterior and posterior horns and the adjacent respective portions of the lateral horn of the lateral meniscus. The lateral meniscus appears to be stretched across the joint space. This is in keeping with its known greater mobility compared to the medial meniscus.

The medial meniscus, being different than the lateral in shape, presents a different roentgen appearance (Fig. 4). The most constant and prominent feature of its roentgen appearance is a wedged-shaped area of increased density, surrounded by air, extending from the capsule laterally into the joint space medially. This represents an "end on view" of the lateral horn. Its length varies from 1 to 1.5 cm. It is quite similar in appearance and density to its counterpart in the lateral meniscus. The chief difference in the roentgen appearance of the semilunar cartilages is in the anterior and posterior horns. On the medial side these horns are not as prominent as they are on the lateral side. They may appear as gradually tapering bands of increased density extending from the apex of the density of the lateral horn toward the tibial spines with a lateral height of 3 to 4 mm. and gradually tapering to a height of about 1.5

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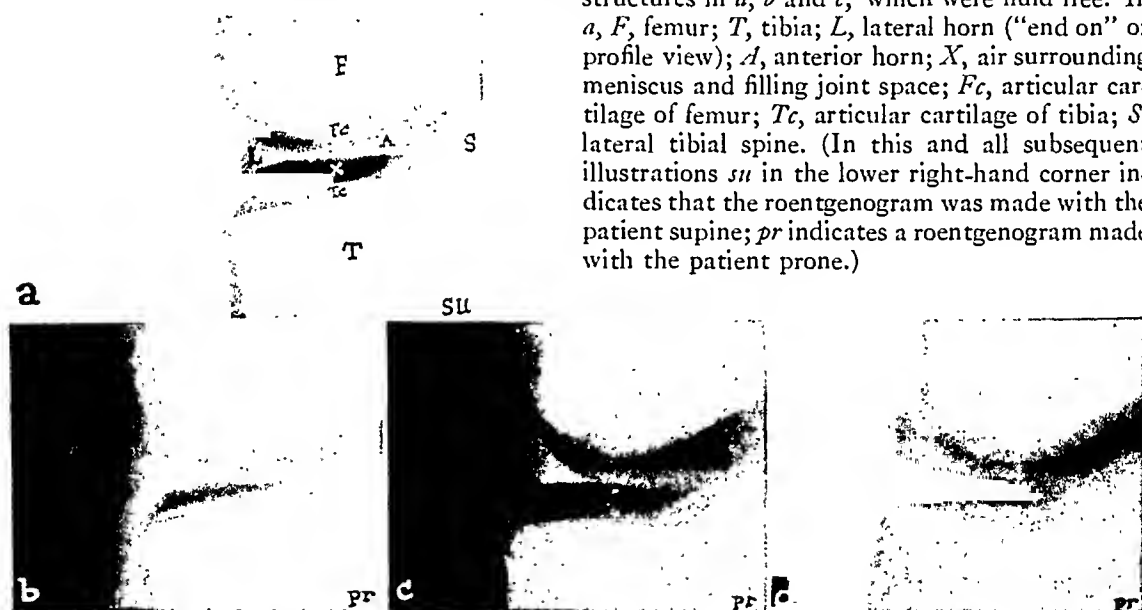
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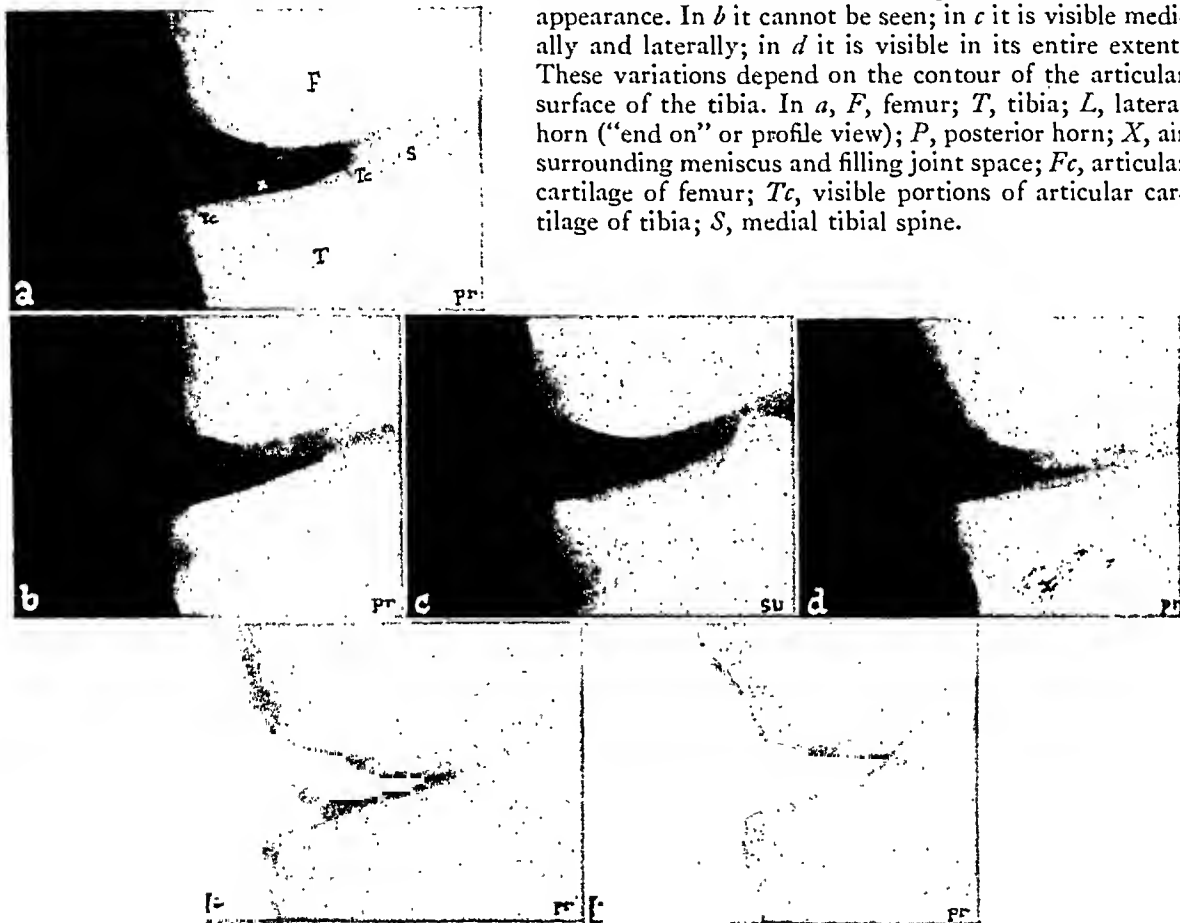


mm. medially. Often they are seen as thin bands of increased density of fairly uniform height (about 1 mm.). It is not possible to "open" the medial compartment of the knee joint as widely as the lateral, probably due to the effect of the strong medial tibial

visualization of the medial meniscus. In general, the appearance of the anterior and posterior horns of the medial meniscus is more variable than that of the lateral and the roentgen examination may have to be repeated in order to obtain satisfactory

FIG. 4. The roentgen appearance of the normal medial meniscus. *a* shows the ideal visualization of the medial meniscus. *b*, *c*, *d*, *e*, and *f* show the other types of visualization frequently encountered. Note the "crossed" appearance of the anterior and posterior horns in *e*. In *f* both the anterior and posterior horns

are visualized. The articular cartilage of the tibia varies in appearance. In *b* it cannot be seen; in *c* it is visible medially and laterally; in *d* it is visible in its entire extent. These variations depend on the contour of the articular surface of the tibia. In *a*, *F*, femur; *T*, tibia; *L*, lateral horn ("end on" or profile view); *P*, posterior horn; *X*, air surrounding meniscus and filling joint space; *Fc*, articular cartilage of femur; *Tc*, visible portions of articular cartilage of tibia; *S*, medial tibial spine.



collateral ligament. Therefore, on occasions the anterior and posterior horns of the medial cartilage do not stand out clearly surrounded by air but must be traced in part through the shadow of the articular cartilage of the femur or tibia. Often both the anterior and posterior horns are visualized on the prone and supine roentgenograms and frequently a crossed appearance is obtained (Fig. 4*e*, *f* and 7*h*). In 2 instances an appearance quite similar to that of the lateral meniscus has been obtained on

visualization. Factors which may contribute to this are: (1) the lessened mobility of the medial meniscus compared to the lateral, and (2) the more variable gross appearance of the medial meniscus. This has been commented on in the literature, four main types of menisci with additional combinations of these main types having been reported.<sup>3</sup>

The articular cartilage of the femur is clearly seen but that of the tibia is not as clearly visualized as it is on the lateral side.

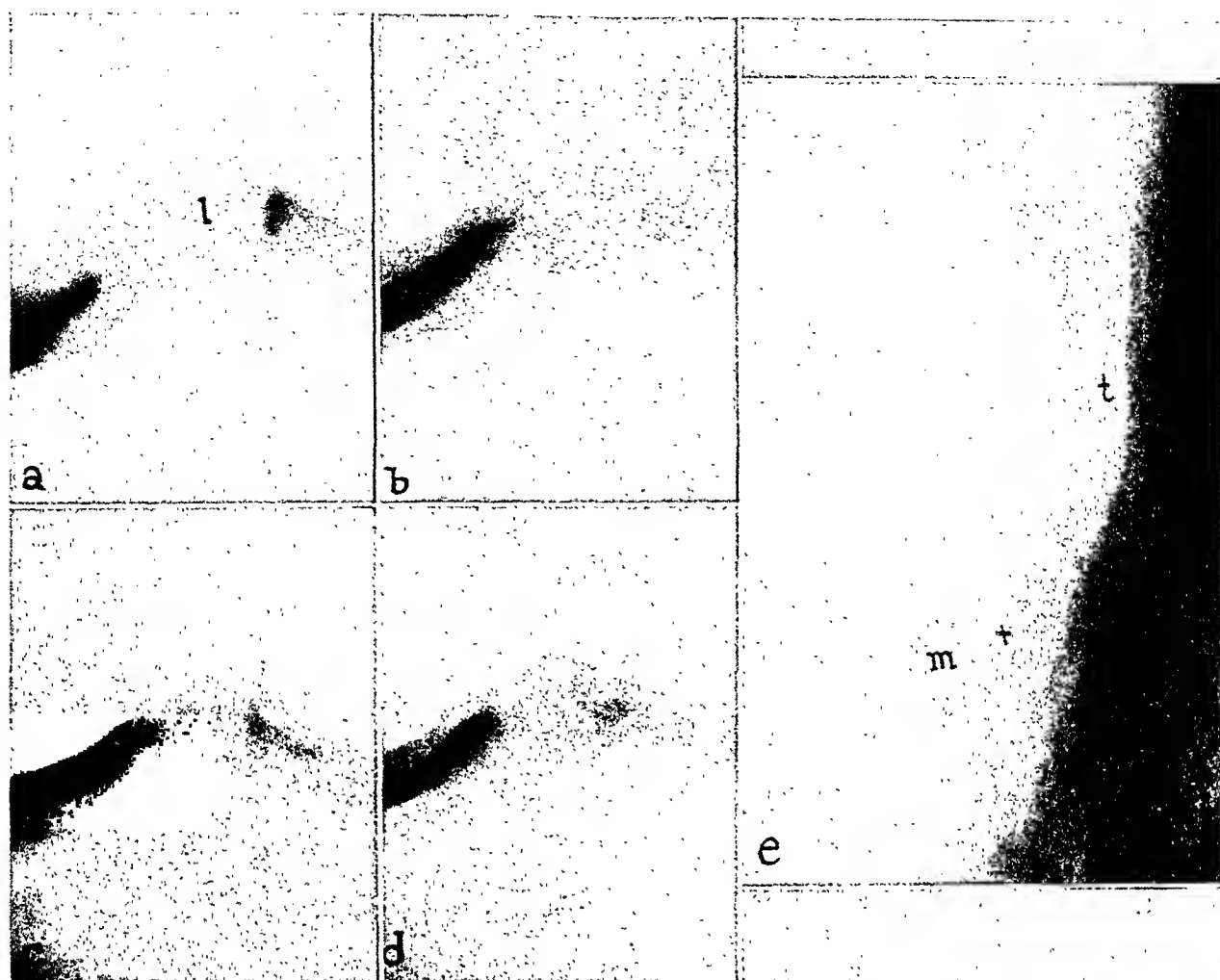


FIG. 5. *a*, *b*, *c*, and *d*, normal cruciate ligaments (*l* in *a*) as visualized by this technique. The outlines are sharp and the ligament is uniform in density. Most of the air is on the side of the joint being "opened up." There often is enough air in the opposite joint compartment to show the other margin of the ligament. (*t*) shows the medial tibial collateral ligament as often visualized during the filming of the medial meniscus (*m*). Note the relatively radiolucent gap (*x*) between the substance of the ligament and the capsule which is the edge of the medial meniscus.

This can be explained anatomically. The medial articular facet of the tibia is concave from side to side and from before backwards. Because of this concavity, the articular cartilage is rarely seen in its entirety, and when it is, it is only seen in 1 or 2 mm. of its height. Usually it is only visible medially near the tibial spines and laterally for a short distance. The cruciate ligament is not apt to be visualized as plainly as on the lateral side, probably because, as stated above, the medial compartment of the joint usually cannot be "opened up" as well as the lateral compartment (Fig. 5*a*, *b*, *c* and *d*).

Quite often the medial tibial collateral ligament may be seen in the soft tissues on

the medial side of the knee joint on the roentgenograms made for visualization of the medial meniscus. There is usually a definite gap between its substance and the capsule of the knee joint to which the lateral meniscus is attached. This, we believe, favors the findings previously reported<sup>2</sup>; that is, the medial tibial collateral ligament is not firmly attached to the medial meniscus (Fig. 5*e*).

The measurements quoted in connection with the descriptions of the two menisci are approximate averages. They will vary with different target-film distances and different object-film distances, in addition to variations in individual knees.

## 2. Pathological Changes in the Menisci.

Pathological changes in the menisci may be recognized on the roentgenograms by any alteration in their appearance from the normal described above. There are no constant pathological pictures (with the exception of bucket handle tears with dislocation) because each case varies. However, if the normal appearances are understood and known, pathological changes are easily detected. In connection with the normal, it is important to point out that all the margins of the menisci are sharply defined and there

are no air shadows visible within the densities produced by the parts of the menisci. The remainder of the joint space not occupied by the meniscus is clear and free of debris. The pathological changes seen may be gross or minimal and consist of fractures or tears and/or degenerative changes (thinning and fraying). Displacement of fractured segments gives rise to bizarre appearances. In some instances degenerative changes, chiefly thinning, are seen without evidence of fractures or tears. This, we be-

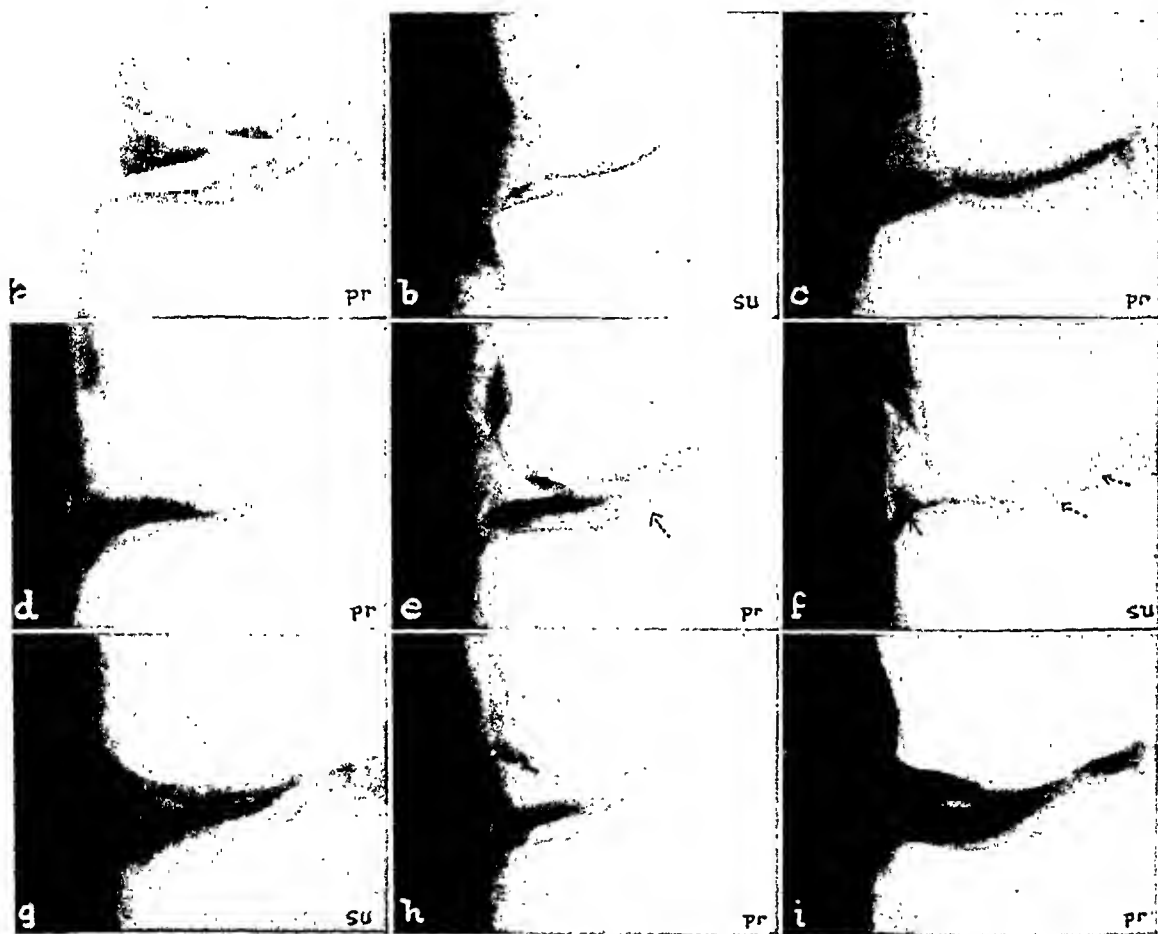


FIG. 6. Roentgen appearance of pathological lateral menisci. In *a*, *b*, and *c* the multiple tears and disintegration of the menisci are marked. In *d*, *e*, and *f* the menisci retain to some degree their gross structure. However, all show multiple tears involving both the lateral horn and the transverse horns (anterior or posterior horns depending on the position of the patient when the roentgenogram was made) of the meniscus. Note the tears in *e*, *f*, and *g* at the attachment of the lateral horn to the joint capsule (solid arrows). In *e* one end of one segment of the transverse horn can be seen at the point indicated (broken arrow). Note the split of the transverse horn in *f* (broken arrows). *h* shows a tear at the capsular attachment of the lateral horn (arrow). The remainder of the cartilage appears normal. Such a tear in the vascular zone, if detected early, might possibly heal under conservative treatment. *i* shows a cartilage in which the primary change is thinning. This is interpreted as possibly being secondary to altered knee mechanics due to a badly fractured medial meniscus, shown in Figure 7*d*.

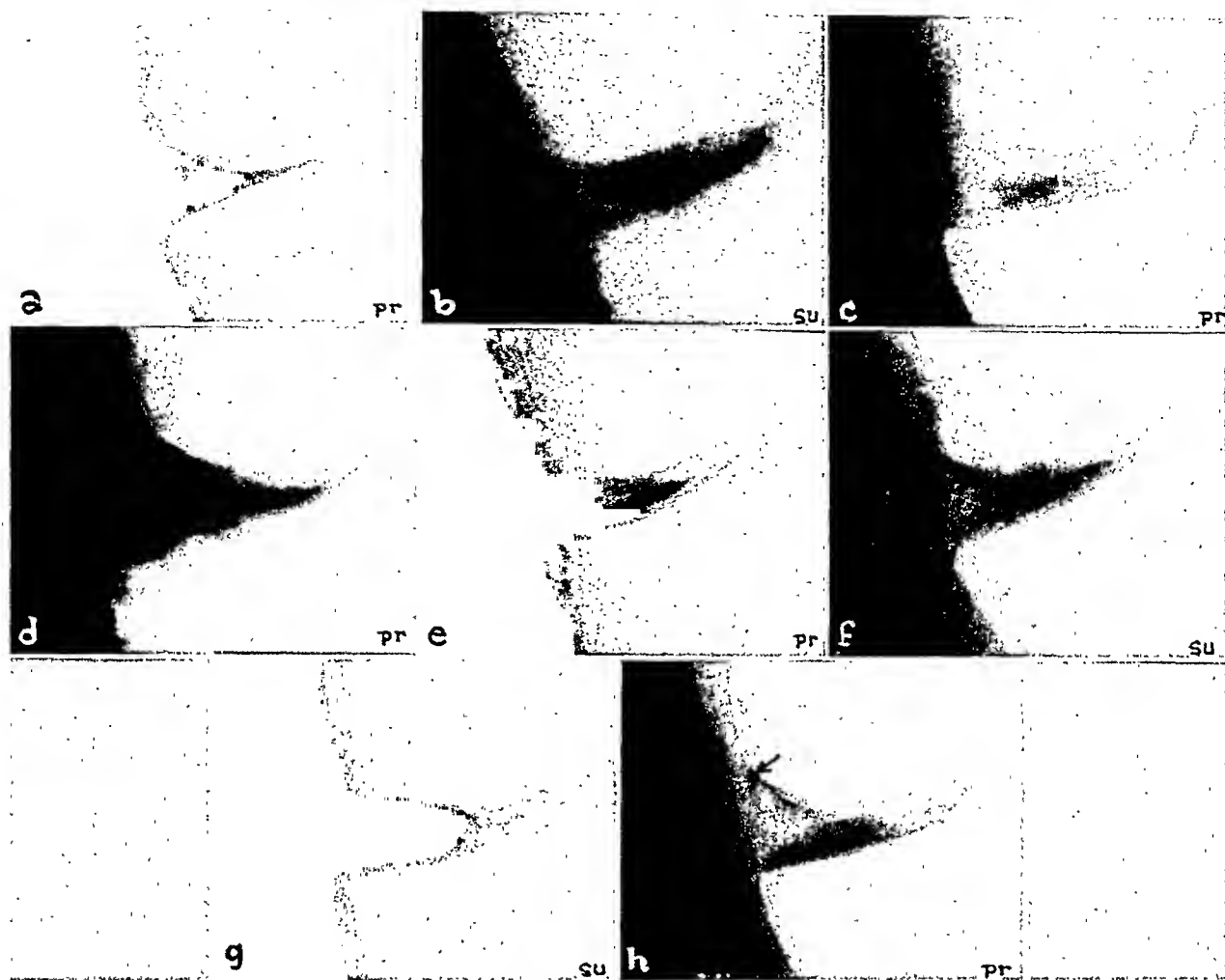


FIG. 7. Roentgen appearance of pathological medial menisci. *a* is a proved typical bucket handle fracture with dislocation of the fractured portion of the cartilage into the intercondyloid region, producing the characteristic picture described in the text. *b* is a similar case. *c*, *d*, *e*, *f*, and *g* show tears and disintegration of both the lateral and transverse horns (anterior or posterior depending on the position of the patient when the roentgenogram was made). In *h* note the crossed appearance produced by a medial meniscus which is normal except for a slight separation superiorly of the attachment of the lateral horn to the capsule (arrow). The smooth character of the defect suggests an old lesion.

lieve, is apt to occur in those instances of severe damage to one cartilage, usually fractures of long standing, in which the other cartilage, probably due to the altered mechanics of the knee joint, undergoes degenerative changes (Fig. 6 and 7).

The bucket handle tears of the menisci with dislocation of the fractured portion of the cartilage into the intercondyloid notch usually result in a fairly constant roentgen appearance; the entire joint space on one side appears full of air, the only evidence of a meniscus being a small segment of the lateral horn attached to the capsule laterally and projecting into the joint space. Most of these injuries, with the character-

istic appearance described above, have been demonstrated in the medial meniscus (Fig. 7*a* and *b*).

The cruciate ligaments are often visualized. On several occasions appearances at variance with the normal have been seen. This probably represents tears of these structures. This feature will require further study.

As yet we do not know how to recognize cysts of the semilunar cartilages, abnormal laxity of the cartilages, or congenital discoid menisci, referred to in the literature.

In several cases defects of the articular cartilage over the femur have been visualized.

It is well to do pneumographic studies on several normal knees to become acquainted with the normal appearances. This will facilitate interpretation of pathologic findings. Frequently views are repeated in order to substantiate findings or obtain better roentgenograms. On at least five occasions early in the study the pneumographic examination has been repeated after several weeks, for additional information, without untoward effects.

#### SUMMARY AND CONCLUSIONS

By the method described above, the semilunar cartilages of the knee may be visualized. The technique is simple and can be performed in any roentgenological laboratory. It does not require hospitalization. It is harmless and has not produced any untoward effects nor aggravated any existing symptoms. The use of small amounts of air in a large joint space removes one of the chief objections to the introduction of air into a joint, that is air embolism, if such a danger exists. The technique of roentgenography insures visualization of all parts (anterior, lateral and posterior horns) of the lateral and medial semilunar cartilages. In many cases it has demonstrated the cruciate ligaments. This, however, has not been the primary objective of the examination. The articular cartilage over the tibia and femur is seen as previously explained.

Visualization of the semilunar cartilages offers the following advantages to the clinician:

(1) It will demonstrate the presence of a pathological meniscus. It is recognized that often it is difficult to diagnose a torn meniscus clinically since other lesions may give similar clinical signs and symptoms.<sup>11,19</sup>

(2) It will indicate which cartilage is involved. This is of importance since the differentiation may be impossible clinically. It is further important because it is often difficult to visualize the cartilage adequately in its entirety during surgery and still more difficult to visualize the cartilage on the side opposite to the side of the arthrotomy. It will, therefore, in many cases,

obviate the necessity for a second incision.<sup>11,13,23</sup>

(3) It has demonstrated two important facts:

(a) *The lateral meniscus is fractured more often than is generally believed.* The literature quotes figures varying from 10 or more to 1 to 2 to 1 as the incidence of the frequency of medial cartilage to lateral cartilage injuries. The majority of the series reported quote the higher ratios. It is our belief that the lower ratios are more correct, the frequency of involvement of the lateral meniscus approaching and possibly equaling that of the medial meniscus. This belief cannot be supported by operative statistics since surgery was not deemed advisable in many of the cases studied. Knowledge of the frequency of involvement of the lateral meniscus may result in a decrease in the number of cases of the so-called "hypermobile meniscus." This usually refers to a grossly normal medial meniscus which has been removed after arthrotomy of the medial compartment of the knee joint on the basis that its attachments are lax, allowing the meniscus to be abnormally mobile and thus produce symptoms. However, the greater mobility of the normal lateral meniscus compared to the medial has been given as the explanation for its less frequent injury.

(b) *In many cases both cartilages are demonstrated to be pathological.* It may be that some of the unfavorable results obtained following surgery can be explained on the basis of the above two facts, namely, removal of the wrong cartilage (medial instead of lateral, judging from the statistics) or removal of one pathologic cartilage and leaving the other, which may be just as severely or more severely damaged, behind. This has been demonstrated in this series by pneumographic studies on knees which have had one cartilage (*the medial*) removed.

(4) By use of this technique, the degree of damage of a meniscus may be visualized. This, together with clinical symptoms, may be a guide as to therapy. This statement is

made with reference to marginal tears of a meniscus in the vascular zone where healing is believed possible. Such tears may be visualized in the lateral horn only. Several such cases have been found.

(5) It may show cruciate ligament tears and pathology of the articular cartilages.

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# MULTIPLE MYELOMA IN A YOUTH\*

By LIEUTENANT COMMANDER HAROLD WOOD (MC), USNR,  
LIEUTENANT J. W. QUINLAN (MC), USNR, and  
COMMANDER E. F. MERRILL (MC), USNR

INFANCY, childhood, and youth are the least common periods of life in which multiple myeloma is reported to occur. Geschickter and Copeland<sup>1</sup> reviewed a large group of reports, and found the mean age of the cases to be fifty-five years, with 80 per cent of the group between the ages of forty and seventy years. Butts<sup>2</sup> analyzed 40 cases of myeloma. He found the average age at the time of diagnosis to be fifty-three years. There are but few reports of this disease below the age of forty years, in which the diagnosis is based upon histological studies of biopsy and autopsy tissue. Three such cases, aged thirty, twenty-seven, and twenty-two years, are noted by Geschickter and Copeland. Magnus-Levy<sup>3</sup> believes that the majority of cases reported to occur in children are not myeloma. However, over an eight year period he collected 7 cases of the disease in infants and children between the ages of sixteen months and twelve years. Three were plasmomas and 4 were myeloblastic tumors; all were proved by autopsy or biopsy.

This paper contains the report of a case of multiple myeloma in a youth nineteen years of age.

## REPORT OF CASE

A male, aged nineteen, was admitted to the hospital May 24, 1943, because of backache, which resulted from an injury in a football game a week before. After the injury he remained ambulatory, but severe pain was constant in the middle of the back, and he vomited once on the fifth day. A roentgenogram taken the day before admission revealed a fracture of the seventh dorsal vertebra.

The only item of positive interest in the past history was the occasional occurrence of night sweats, which the patient attributed to an excess of blankets. He had had mumps, with involvement of the left testis. There had been no

loss of weight, and the general health of the patient was good. This last was verified in a letter from the parents.

The admission temperature was 100° F., the pulse rate 88, the respiratory rate 20, and the blood pressure 120/70. Tenderness in the area over the seventh dorsal vertebra and some paravertebral tenderness were the only positive physical findings. The neurological examination was negative. The regional lymph nodes were not enlarged. No masses were palpable in the renal areas, and the breasts were normal. The left testis was atrophic, but the right testis was of average size. The rectal examination was negative.

*Roentgen Findings.* May 26: "There are multiple areas of decreased density, irregular in shape, in all the ribs, in both scapulae, both clavicles, and in some of the vertebrae of the dorsal spine. There is also a fracture of the anterior portion of the fourth rib on the right side, and a compression fracture of the seventh dorsal vertebra. There are questionable areas of rarefaction in both innominate bones which might be bony disease or overlying colonic gas. Opinion: Multiple myeloma." May 28: "The mottling of the pelvic bones is again seen, as well as mottling in the upper ends of both femurs and in the sacrum. The same mottling is noted in the skull. The findings are most consistent with multiple myeloma." July 6: "Films of ribs, lateral skull, dorsal spine and pelvis show no changes since the last examination."

On June 10 a sternal puncture was done. Smears showed bits of marrow, in which no tumor and no predominance of plasma cells were evident.

*Laboratory Findings.* Urinalysis was negative, except for coarsely granular and hyalin casts in one specimen. On five occasions, tests for Bence-Jones protein were negative. Five erythrocyte counts expressed in millions per cubic millimeter were: 3.55, 2.89, 3.07, 3.13, and 2.49. Hemoglobin determinations by the Hayden-Hausser method were: 8, 8.5, and 7.5 gm. per 100 cc. Leukocyte counts were 5,000, 2,650, 1,550, and 4,700 per cu. mm. Three differential

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leukocyte counts averaged: juvenile cells 1 per cent, band cells 2 per cent, segmented cells 54 per cent, lymphocytes 40 per cent, and monocytes 3 per cent. No abnormal types of cells were seen. In the smears there were hypochromia and slight anisocytosis of the red blood corpuscles. A blood platelet count was 125,000 per cu. mm. The blood Kahn test was negative. The erythrocyte sedimentation rate, Cutler method, was 33 mm. in one hour. Blood chemistry determinations: total protein 9.7 per cent, albumin 4.09 per cent, globulin 5.61 per cent, non-protein nitrogen 42 mg. per 100 cc., calcium 8 mg. per 100 cc., phosphatase 22 Bodansky units, sugar 136 mg. per 100 cc. A phenol-sulfonphthalein renal function test showed the following excretion rate: fifteen minutes, 15 per cent; one hour, 35 per cent; two hours, 25 per cent. Total excretion of dye, 75 per cent. Mosenthal's renal function test gave the following results: 990 cc. of urine excreted during the day, 600 cc. excreted during the night, total excretion, 1,590 cc. for twenty-four hours. The specific gravity ranged from 1.007 to 1.013.

On June 13 a biopsy was taken from the eighth right rib in the anterior axillary line. Most of the cancellous bone was replaced by



FIG. 1. Typical lesions in ribs, scapulae, and clavicles. Note that the ribs are closer together at the level of the compressed seventh thoracic body.

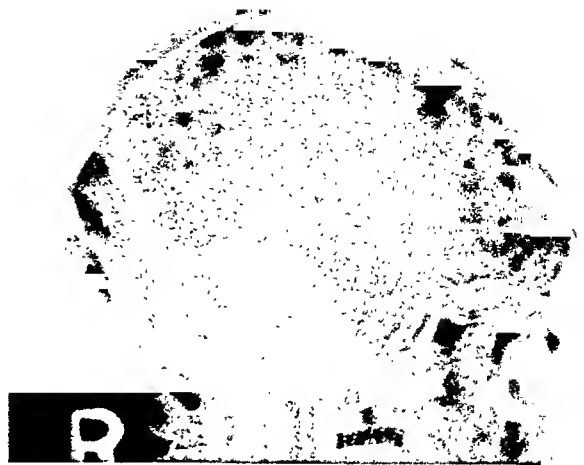


FIG. 2. Note the multiple destructive bone lesions involving primarily the diploic portions of the bone.

soft, bloody, reddish-gray tissue leaving a thin shell of cortex surrounding it. Sections of this soft tissue were examined by the pathologist at this hospital, and unstained sections from the same blocks were submitted to three other pathologists for their opinion. The four reports are given in the sequence received.

1. Report of Lt. Comdr. Harold Wood, Pathologist, U. S. Naval Hospital, Newport, R. I.

"Sections revealed a hyperplastic cellular bone marrow, showing overgrowth with unidentified mononuclear cells, but with some plasma cell types. There were numerous cells representing normal marrow cell types. Mitoses were not common. Bone resorption (in the spicules) was prominent. Opinion: Suggestive of myeloma, but am unable to make a definite diagnosis on these sections."

2. Abstract of letter from Lt. Comdr. Shields Warren (MC), USNR, New England Deaconess Hospital, Boston, Massachusetts, Consultant in Pathology for the First Naval District: "The clinical history is certainly a good one for multiple myeloma, and the serum protein is elevated particularly in view of the anemia present. The sections show some typical plasma cells, especially in the section with a moderate amount of bone present. In other sections, the cells are less typical, but some of the plasma cell type are there. I would, therefore, classify this case as one of multiple myeloma of plasma cell type, not completely characteristic."

3. Abstract of letter from Dr. H. E. MacMahon, Professor of Pathology and Bacteriology, Tufts College Medical School, Boston,



FIG. 3. Multiple typical lesions of plasma cell myeloma in the pelvic bones with no evidence of cortical destruction.

Mass.: "I spent a good deal of time yesterday going over the three slides that you sent us. In only one of the three sections was there any recognizable tumor tissue. The growth is composed of a very primitive cell. There is little cytoplasm and the nucleus is rather polymorphous. There is no pattern as far as the growth is concerned, so that one is merely left with cells from which one might reach a diagnosis. Ninety-nine per cent or more of the cells are so primitive and undifferentiated that they cannot be compared with any adult cell found normally in bone marrow nor, for that matter, in the developing marrow of the embryo. Among these cells, there is a very occasional well formed plasma cell. The appearance of plasma cells in bone marrow is not an uncommon finding, so that finding one or two of these might have no more significance than were one to pick up a mature red cell or a polymorphonuclear leukocyte or even a megakaryocyte under similar circumstances. I believe, however, that I was able to trace transitions between the dominating cell and a plasma cell. If this observation is correct, then the presence of a plasma cell assumes considerable significance. It is a little bit like spending an afternoon or an evening looking through one of those undifferentiated retroperitoneal tumors and coming out in the end by finding a single cell with cross striations which you can recognize as a striated muscle fibre. When we do this we are very apt to label our tumor a rhabdomyosarcoma. In the same way my diagnosis of your slide might be a plasma cell myeloma and yet, actually, it is a tumor that might more ac-

curately be called an undifferentiated myeloma."

4. Report of Lt. Comdr. C. F. Geschickter (MC), USNR, Pathologist, U. S. Naval Hospital, Bethesda, Maryland:

"The sections show eroded spicules of bone widely separated by hyperplastic marrow. In places the normal bone marrow is crowded out by a proliferation of cells slightly larger than lymphocytes. They have either circular or lobed nucleus with a fine distribution of chromatin. There are occasional mitotic figures. The majority of these cells are not the characteristic plasma cells found in the usual type of multiple myeloma. The cells seem to be more immature in form and of the myelocytic series and have a tendency for their nuclei to split into lobes. Pathologic diagnosis: Multiple myeloma, primitive myelocytic series."

During the remainder of the stay in the hospital, the patient was reasonably well. There were occasional elevations of temperature, up to 101.3° F. The blood pressure was 125/70. The pulse rate varied from 79 to 98, and the respiratory rate varied from 16 to 30. Back pain of moderate intensity persisted. Three small transfusions of citrated blood were given. At one time a systolic murmur was heard over the mitral area, but there was no tachycardia. Except for one period of faintness, and two days of nausea and vomiting, the course was uneventful. The biopsy wound healed uneventfully. On July 5 the patient was transferred to

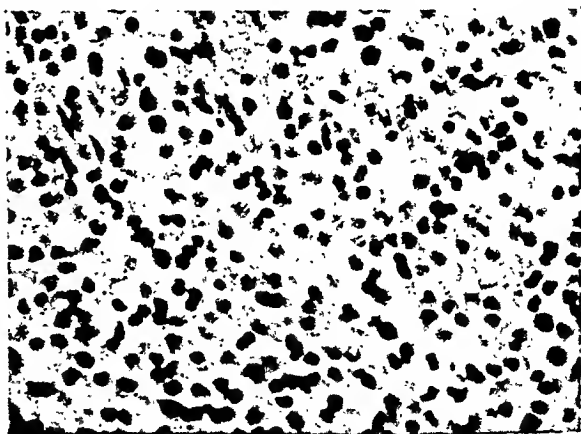


FIG. 4. Biopsy specimen which illustrates the undifferentiated character of the tumor cells; the remote resemblance to plasma cells of the chromatin distribution in some of the cell nuclei; and the lobulated appearance of some of the nuclei.

the U. S. Naval Hospital, Brooklyn, New York, for palliative roentgen therapy.

Progress note from Brooklyn Naval Hospital, September 22, 1943: "Further roentgen studies supported by a review of the biopsy have established the diagnosis as being multiple myeloma. Treatment has consisted of small doses of roentgen therapy to the chest and pelvis. Generally this patient has improved and has no complaints except for weakness. Follow-up roentgen studies, however, show extensive and uncontrolled disease involving almost the entire skeletal system."

#### SUMMARY

A case of multiple myeloma in a youth, aged nineteen, has been presented. The disease was discovered following a pathological fracture of a vertebra. Roentgeno-

graphically the appearance and distribution were typical. A biopsy from a rib was examined by four pathologists. The consensus was that the tumor is a primitive atypical myeloma, but there was some uncertainty and difference in opinion as to the cytogenesis of the tumor; that is, whether it developed from the plasma cell or the granulocytic series of marrow cells.

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# CHOLEDOCHODUODENAL FISTULA

## CASE REPORT

By MAJOR JACOB WEINBERGER, and CAPTAIN ABRAHAM ROSENTHAL\*

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**S**PONTANEOUS internal fistula of the biliary tract, although by no means considered rare, does not occur sufficiently often so that it may be diagnosed readily. In fact, clinically, the condition is so obscure that almost complete reliance must be placed upon roentgenographic study for a diagnosis to be made. During the past fifteen years more cases have been reported than ever before because of the awareness of roentgenologists of its existence and the improved technique of roentgenography.<sup>1,2,3,4,5,8,9,10,11,13</sup> These lesions may be practically unsuspected clinically simply because of the existence of a wide stoma at the point of the fistula and thus they are only demonstrable at the time of roentgen studies.

The causes of retrograde filling of the biliary tract during the course of studying the alimentary tract by the use of barium may be listed as follows:<sup>1,8,12</sup> (1) the penetration of gallstones from the gallbladder or, very much less frequently, the common duct, into the duodenum; (2) the extension of an inflammatory process by contiguity from the gallbladder, or the common duct, to the duodenum, or vice versa; (3) the establishment of contiguous inflammation and fistula formation arising from a primary lesion in the colon; (4) operative interference resulting in either a cholecystoduodenostomy or cholecystogastrostomy; (5) the questionable physiological reflux from the duodenum through a patent sphincter of Oddi into the biliary tract.

The above causes have been listed in the order of their supposed frequency of occurrence.

As to the possibility of physiological reflux via the ampulla of Vater, experimental work by Beal and Jagoda<sup>1</sup> showed that it

was relatively impossible to fill the biliary tract in a cadaver even by the use of enormous amounts of pressure exerted from within the duodenum.<sup>7</sup> The demonstration of a fistulous communication between the biliary tract and the colon is best made by means of a barium enema.<sup>4</sup> The presence of air alone in the biliary tract is by itself diagnostic evidence of the existence of a fistula between the biliary and alimentary tracts.

Borman and Rigler<sup>2</sup> have aptly summarized the roentgenologic criteria for the diagnosis of internal biliary fistula as follows:

- 1) Direct Signs.
  - a) Gas or barium or both in the gallbladder or biliary tree.
  - b) Mucous membrane changes at the stoma of the fistula.
- 2) Indirect Signs.
  - a) Non-functioning gallbladder (cholecystogram).

In differentiating gas in the biliary tract resulting from a fistula and gas resulting from emphysema in bacterial infection within the gallbladder, the latter is more apt to be bubble-like in its appearance and usually does not extend beyond the confines of the gallbladder shadow and cystic duct. As a further aid in establishing the diagnosis of internal biliary fistula, cholecystography is of value since it usually reveals either a non-functioning or poorly functioning gallbladder. The finding of a normal gallbladder shadow, in a case where the barium meal study has suggested the possibility of internal biliary fistula, should cause one to reconsider the latter diagnosis.<sup>6,14</sup>

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The case we are reporting is one in which we believe the course of the disease was such that the original pathologic condition occurred in the duodenum and spread by contiguity to the common duct with a resultant fistula formation.

#### CASE REPORT

A white male selectee, aged thirty-two, reported for induction in December, 1943. He gave the following history:

He was perfectly well until six years ago when he noticed the onset of epigastric pain at night



FIG. 1. Demonstration of the irregular, deformed duodenal cap with the Y-shaped fistulous tract issuing therefrom outlining the common, cystic and common hepatic bile ducts with some barium in the neck of the gallbladder.

which was so severe that it aroused him from sleep. He obtained relief by taking sodium bicarbonate. This symptom persisted for the next five years during which there were periods of approximately two to three weeks when it would be manifest and then again periods of three to four weeks' duration when there would be complete freedom from all symptoms. About one year ago he noticed that the pain began to occur regularly about two hours after each meal during the day, besides its occurrence during the night. He still continued to obtain



FIG. 2. The right oblique view showing the same as Figure 1.

relief from the use of alkalis. His chief complaint at the time of examination was localized epigastric pain which came on about two to three hours after meals and which was relieved by food, but especially by the use of magnesium



FIG. 3. A roentgenogram six hours after the ingestion of the barium showing air in the biliary tract and flecks of barium in the gallbladder.



FIG. 4. Very poorly visualized gallbladder shadow following the oral administration of three doses of tetraiodophthalein with a very tiny amount of residual barium in the fundus of the gallbladder. (Cholecystography was performed shortly after the barium series because of the limited time allowed for study of this case.)

hydroxide and somewhat by milk. By this time the pain was present both day and night, with the night symptoms more marked. He had frequent vomiting spells which gave him relief. At no time did he experience any single episode of acute, sudden, sharp abdominal pain. There had never been any diarrhea. Neither had there been any hematemesis or melena. During the entire course of his illness he never visited a physician. His family history was irrelevant. He was employed as a porter in a factory. He took alcohol in minimal quantities; he rarely smoked. He had no previous illness or injuries. He denied venereal disease.

Physical examination revealed a small-framed, thin male who appeared in some slight distress. His facies was markedly triangular with deep nasolabial grooves conforming to the type of facies described by Draper as the "ulcer facies." Examination of all systems was entirely negative except for the presence of a single small area of exquisite tenderness in the epigastrium at a point slightly above midway between the xiphoid and the umbilicus.

**Roentgenographic Examination.** During the course of the ingestion of the barium meal the duodenal cap appeared deformed and somewhat irritable. At that time no evidence of communication between the cap and the biliary tract was observed. However, the roentgenograms revealed the barium-filled outline of the cystic, common hepatic, and common bile ducts with barium in the gallbladder itself and also air in the biliary tract in some of the roentgenograms. Oral cholecystography was performed and it was found that the gallbladder concentrated poorly. During cholecystography, however, it was not possible to show the communication by contrast medium between the biliary tract and the duodenum, but again air was seen in the biliary tract. The roentgenograms were interpreted as representing an old duodenal ulcer which had formed a fistulous communication with the common bile duct.<sup>5</sup>

Since the study was carried out for diagnostic purposes only the selectee was rejected for service in the Armed Forces and advised to see a physician.

#### SUMMARY

(1) A case of choledochoduodenal fistula is presented.

(2) A brief review of some of the pertinent literature is noted.

(3) Some of the roentgen diagnostic criteria of this condition are stressed.

The authors are indebted to Sgt. P. Murphy and T/5 G. Dickey of the WAC Medical Detachment for their assistance in studying this case and to Cpl. H. Owen of the Signal Corps for the reproductions of the roentgenograms.

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# PHOTOELECTRIC TIMING IN GENERAL ROENTGENOGRAPHY\*†

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## INTRODUCTION

IN A PREVIOUS publication on the automatic control of roentgenographic exposure, one of us described a photoelectric timing mechanism<sup>1</sup> that has been in use for more than two years on our gastric filming fluoroscope. A similar timer suitable for photofluorography<sup>2</sup> has been developed in our laboratory and for many months a number of these units have been in operation on photofluorographs belonging to the United States Navy, the United States Army and the United States Public Health Service. One of these, at the time of this writing, has made over 100,000 exposures.

For the past two years our laboratory has been under contract with the Office of Scientific Research and Development, and at the request of that agency we have applied for several patents covering various phases of our work. The University and the authors retain no financial interest whatever in these patents, and have assigned all of them to the government. The scarcity of electronic materials makes it impossible for commercial manufacturers to supply phototimers for civilian use at this time, but the government has licensed several companies and as soon as war restrictions can be relaxed commercial phototimers will be produced.

The present paper deals with the application of automatic timing to general roentgenography, which includes the roentgenographing of such parts as the spine, the pelvis, the urinary tract, the gallbladder, the chest, the shoulder, the skull, the knee, the ankle, etc., with and without intensify-

ing screens and with and without the Potter-Bucky grid. Automatic phototimers consist of two parts—a detector unit and a condenser-thyratron-relay system which for convenience we call the “control chassis.” In the exposure meter<sup>3</sup> the detector is a lightproof metal box provided with a cover that is transparent to roentgen rays and containing a 931 phototube and an overlying fluorescent screen. The detector we have used for photofluorography<sup>2</sup> focuses on the active surface of the phototube a 4 by 10 inch segment of the fluoroscopic image of the upper lung fields. In our gastric-filming fluoroscope the phototube lies 1½ inches in front of the 4¼ by 7 inch fluoroscopic screen and scans the entire screen.<sup>1</sup>

When roentgen rays fall on the fluorescent screen, it emits visible light which causes the phototube to conduct a small electrical current. The magnitude of this photocurrent is proportional to the light emitted by the screen, and therefore to the intensity of the roentgen rays that induced the visible radiation. The photocurrent enters the control chassis where it is collected by a condenser and when the charge on this condenser reaches a critical value the thyratron system ionizes and activates a normally closed relay which in turn interrupts the roentgen-ray exposure.

The time required for the charging of the condenser determines the length of the exposure and varies with the voltage applied to the phototube, the size of the condenser and the intensity of the radiation reaching the detector. The first two factors are fixed at the time the instrument is calibrated,

\* The work described in this paper was done under a contract recommended by the Committee on Medical Research between the Office of Scientific Research and Development and the University of Chicago.

† Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24-26, 1944.

‡ Surgeon (R) United States Public Health Service.

leaving only the third factor variable depending on the output of the roentgen tube and the thickness and density of the part being examined. All else being equal, the thicker the part, the lower will be the intensity of the light emitted by the fluorescent screen, and therefore the longer the

gallbladder, knee, etc., because they are influenced by radiation passing around as well as through the region of interest. For the same reason the hand and wrist require very small detectors.

In a preliminary model, we provided multiplicity of detector sizes by employing

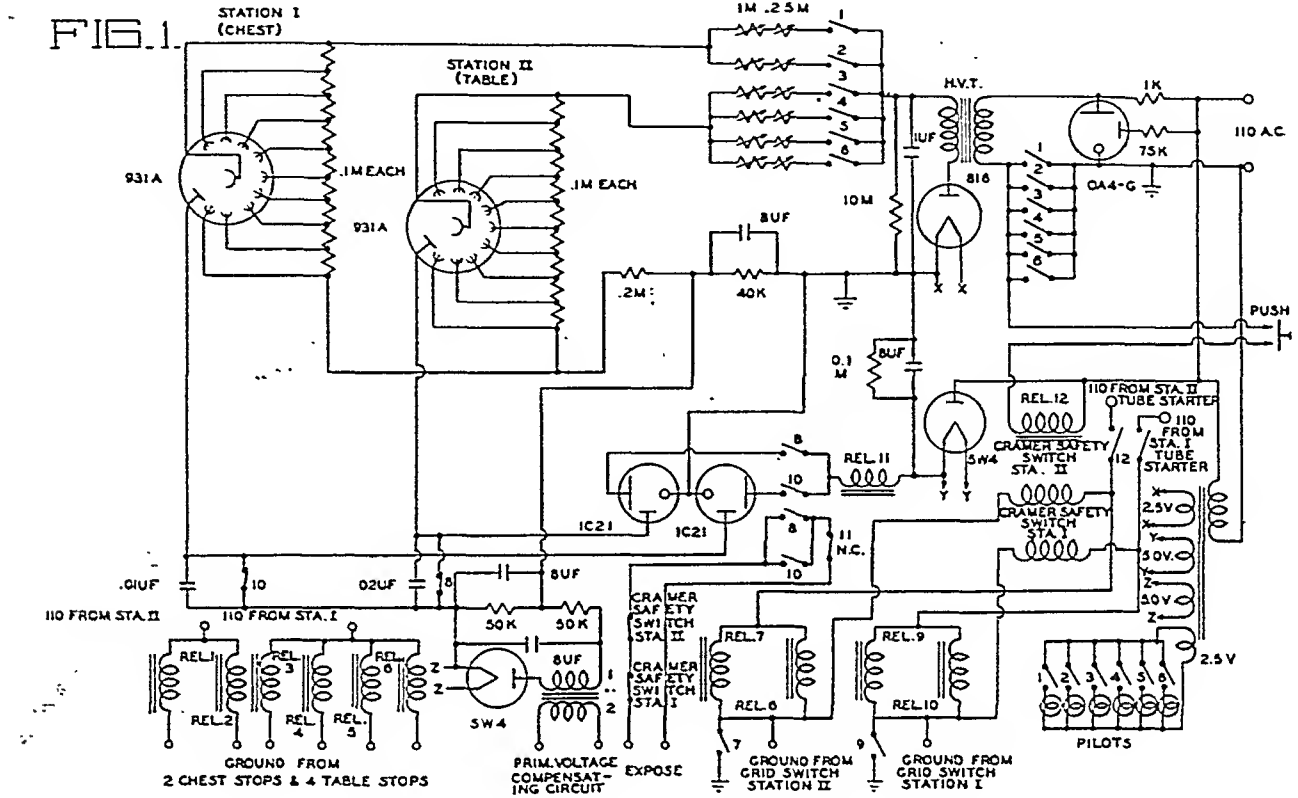


FIG. 1. Two-station, multiple-stop phototimer.

time for charging the condenser and the longer the roentgen-ray exposure.

RADIATION DETECTOR FOR GENERAL ROENTGENOGRAPHY

Experience with the 2 by 2 inch detector of the exposure meter<sup>3</sup> has shown us that for some phases of general roentgenography such a surface is too small, for others too large. The small surface serves well for the skull, knee, shoulder, and gallbladder but is too small for the trunk and pelvis and too large for the hand and wrist. For trunk and pelvic roentgenography a larger detector gives better results by minimizing the effects of local areas of decreased density, such as pockets of gas in the bowel; but such large detectors fail in the case of the

a 7 by 7 inch detector mounted beneath the film tray of a Potter-Bucky grid and interposing between film and detector lead sheets having various sized openings or "stops." That detector, a roof-shaped, light-tight metal box with the phototube at the apex and the fluorescent screen (Patterson photoroentgen) at the base, had an over-all thickness of about 5 inches, which precluded its use on grids mounted in conventional tilt tables. By moving the phototube to the side of the detector box with its active surface directed obliquely toward the screen and toward a mirrored image of the screen, the thickness of the detector has been reduced to 1 3/4 inches, of which 3/4 inch can be countersunk into the base of the grid (Fig. 13 and 14). This means that the

thickness of the Potter-Bucky grid complete with radiation detector is  $3\frac{3}{4}$  inches, which is 1 inch thicker than the conventional grid.

Some commercial tilt tables will take a  $3\frac{3}{4}$  inch grid, and it is hoped that the manufacturers of the others may be able to find

the exposed edge of the disc indicate which stop is in position. Four squares of lead cemented to the upper surface of the disc cover the detector completely except for the holes or "stops" that are cut through the lead and steel.

*Stop No. 1:* This has a 2 inch circular

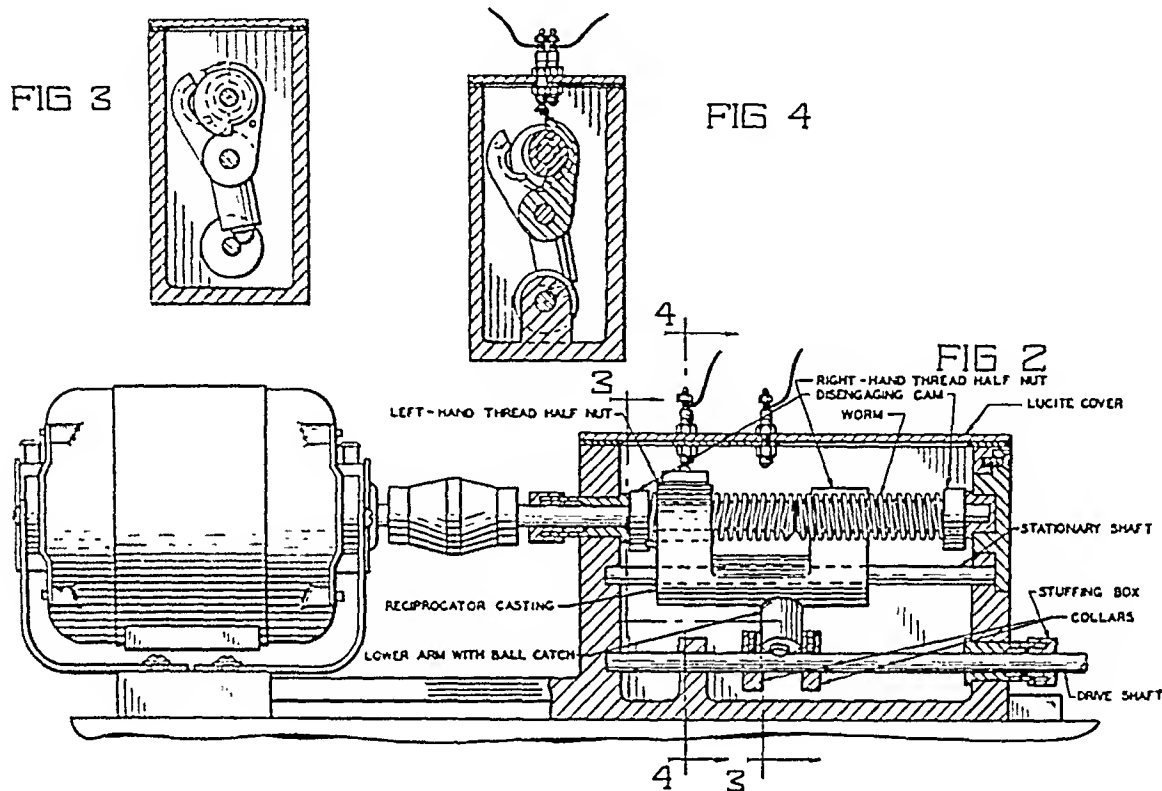


FIG. 2, 3 and 4. Detail of reciprocator.

means of altering them so that they too will take grids equipped with radiation detectors.

#### DISC WITH MULTIPLE STOPS

In the experimental model we placed the various lead stops in the bottom of the film tray but in the current model the stops are attached to a steel disc mounted below the tray and above the detector (Fig. 5, 6, 8, 10, 11 and 12). A short axle fixed to the disc passes downward through a brass bushing and is retained by a brass bar known as the "grounding bar." A spring lock engaging four notches on the periphery of the disc registers each of the stops precisely above the detector, and lettering and a symbol on

aperture located at the center of the detector. It is used with 8 by 10 inch and 10 by 12 inch cassettes where there is no central spring to obstruct passage of the rays and is employed for examination of the skull, gallbladder, shoulder, knee, etc.

*Stop No. 2:* Sixteen apertures, each  $\frac{1}{2}$  inch in diameter, are located four in each corner of the detector, leaving vertical and transverse bands of intact lead between the four groups of holes. This arrangement distributes sampling over a wide area and cancels the effect of the central spring if 14 by 17 inch cassettes are used but may, however, be used with smaller size films as well. This stop is used for roentgenographing the chest, abdomen, and pelvis.

*Stop No. 3:* Four apertures, each  $\frac{5}{8}$  inch in diameter, are placed two above, two below the center of the detector with a  $\frac{3}{4}$  inch band of lead separating the pairs. This stop is employed primarily for lateral roentgenography of the spine and may be used with cassettes of any size.

*Stop No. 4:* This stop has a single  $\frac{1}{2}$  inch aperture placed at the center of the detector and is used for roentgenographing the hand, wrist, fingers, and toes.

#### GROUNDING COMMUTATOR

A circular bakelite plate equipped with four brass contact buttons placed at 12 o'clock, 3 o'clock, 6 o'clock, and 9 o'clock is clamped to the base of the grid by the nut of the bushing in which the axle turns. Brass pins that fix the buttons in the bakelite are soldered to wires that lead to the chassis and a thin sheet of fiber insulates this part of the assembly from the frame of the grid. The bushing and axle, however, are in electrical contact with the frame of the grid, which in turn is connected to ground, and a ball catch at the outer end of the grounding bar distributes ground to contact buttons No. 1, 2, 3 or 4, depending on the particular stop that is registered over the detector. If stop No. 3 is in front of the detector, commutator button No. 3 delivers ground to the chassis but buttons No. 1, 2 and 4 are dead. If none of the stops is centered directly over the detector—that is, if the disc is not properly set with its spring lock engaging one of the four notches at the periphery—all the contact buttons are dead and the machine will not operate.

#### DETECTOR FOR ROENTGENOGRAPHY OF THE CHEST

This detector, oblong in shape and equipped with a  $3\frac{1}{2}$  by 10 inch Patterson photoroentgen screen, is placed transversely behind the film carriage, its lower edge at the center of the film. The disc-axle-commutator assembly is similar to that used with Station II except that here only two stops are used.

*Stop No. 1:* This stop has two  $3\frac{1}{4}$  inch apertures, one at either end of the detector screen. It is used for the frontal view of the chest.

*Stop No. 2:* This is a single 2 inch aperture in the center of the detector and is

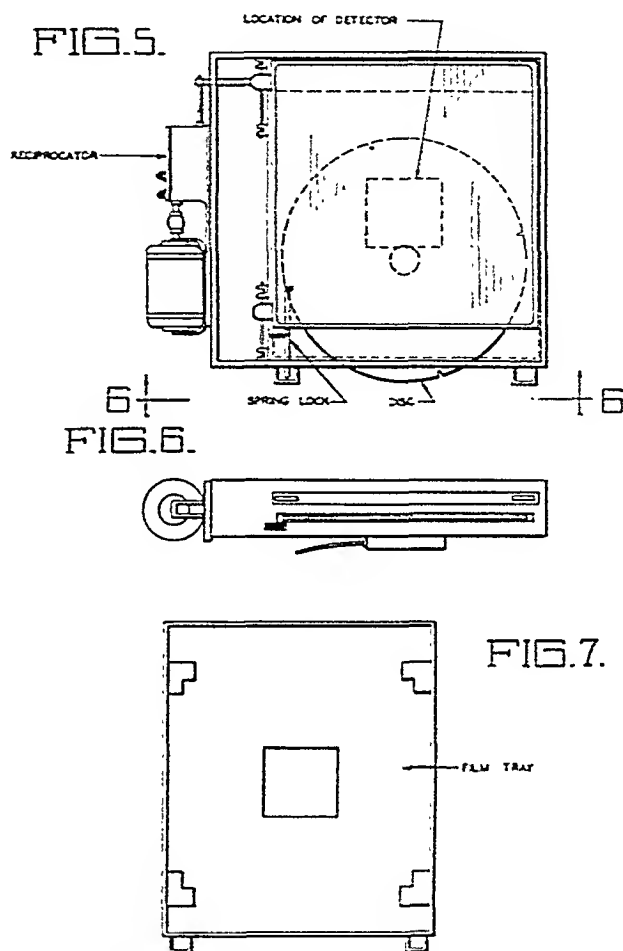


FIG. 5. Grid, reciprocator, stop, detector assembly viewed from above.

FIG. 6. Same, viewed from the side.

FIG. 7. Film tray.

used for lateral roentgenography of the chest.

#### SPECIAL CASSETTES

It is essential that all film holders used with phototimers have radiolucent backs. In the case of cardboard holders this requires merely the removal of the sheet lead from between the film envelope and the cardboard, but in cassettes one must not only remove the lead but also make sure that the back is of radiolucent material, such as aluminum or plastic. As far as we

have been able to determine, the lead that is always placed in the backs of film holders serves no useful purpose.

We prefer cassettes in which the 14 by 17 inch size has three transverse spring straps, the 10 by 12 inch and 8 by 10 inch size

that has come through the patient and the film to enter the detector. This requires discarding the cassette clamp provided by the manufacturer and employing plywood adaptors when 10 by 12, 8 by 10 and 7 by 17 inch films are used.

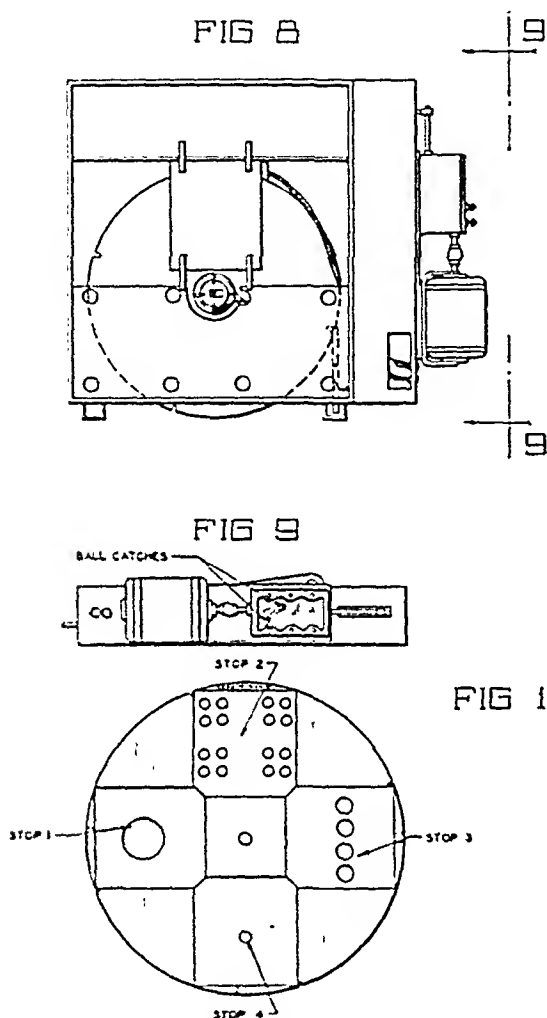


FIG. 8. Grid assembly viewed from below to show detector and grounding commutator.

FIG. 9. Plan of reciprocator to show location switch on lucite cover.

FIG. 10. Detail of disc with four "stops."

only two; but any cassettes will serve provided they are all the product of one manufacturer, and therefore all of approximately the same degree of radiolucency.

#### FILM TRAY

A  $5\frac{1}{2}$  by  $5\frac{1}{2}$  inch window is cut out of the center of the film tray to allow radiation

#### MOTOR-DRIVEN RECIPROCATOR FOR THE POTTER-BUCKY GRID

Much of the advantage of phototiming would be lost if conventional Potter-Bucky grids were employed because it would be necessary to make an empirical estimate of the exposure time and then set the grid for a travel time something greater than that. With the reciprocator the grid starts as soon as the station switch is closed and the rate of travel remains constant regardless of the length of exposure.

With the years, roentgenologists have come to accept the dictum that the Potter-Bucky grid must be in motion before the exposure starts and must continue in motion until after the exposure has ended, but actually it is permissible for the grid to stop and reverse direction while the exposure is in progress, provided the stoppage is brief. We have determined experimentally that a reversal accomplished in approximately  $1/100$  second is sufficiently fast to prevent grid lines provided the exposure time exceeds  $\frac{1}{2}$  second; and, with the able assistance of our precision machinists, Mr. Angrabright and Mr. Doles, we have been able to develop a reciprocator having this characteristic.\* The current model of the reciprocator is shown in Figures 2, 3 and 4.

A rubber-mounted  $1/40$  horsepower, alternating current motor drives a worm at a constant speed of 1,725 r.p.m., rotation being clockwise as one looks at the outer end of the worm. The inner half of the worm (that is, the end toward the motor) has a left-hand thread, the outer half a

\* Early models of the reciprocator were demonstrated at the meeting of the American Roentgen Ray Society in September, 1942, and the Radiological Society of North America in December, 1942.

right-hand thread. Sliding on a stationary rod located below the worm is a reciprocating member that has two upper arms, each bearing a half-nut that faces the worm, and a single lower arm equipped with a ball catch. Below the stationary rod lies a drive shaft which slides in a bearing, carries a pair of collars to engage the lower arm of the reciprocating member, and at the outer end passes through a stuffing box to drive the grid. When the motor runs, the grid moves back and forth making a complete cycle in 1.5 seconds and reversing direction in approximately  $1/115$  second. When a 50-line grid is used, grid lines do not become noticeable until the exposure time is reduced below 0.2 second.

#### OPERATION OF RECIPROCATOR

When the right-hand thread half-nut is engaged with the outer half of the worm, the grid is driven outward—that is, away from the motor—until a cam attached to the outer end of the worm strikes a disengaging pin in the nut, forcing it out of engagement. This brings the left-hand thread half-nut into engagement with the central portion of the inner half of the worm. As the right-hand thread half-nut is forced away from the outer end of the worm, the ball catch in the lower arm of the reciprocating member rides over the drive shaft and snaps down on the other side, completing the thrust that was begun by the disengaging cam and retaining engagement between the left-hand thread half-nut and the worm. The grid now travels inward until the left-hand thread half-nut is disengaged by a second cam at the inner end of the worm, upon which the grid reverses again—the cycle being repeated as long as the motor continues to run.

When they are properly adjusted, the cams disengage one half-nut and engage the other  $90^\circ$  after they strike the disengaging pins, and since the worms and cams revolve at 1,725 r.p.m., this means that reversal is accomplished in approximately  $1/115$  second.

#### GRID SWITCH

The worm, half-nuts, cams, etc., run in oil to reduce wear and noise, and the lucite cover of the oil housing carries a switch which delivers a pulse of ground just after each reversal of the grid. This switch consists of two ball catches attached to the lucite cover and connected together by a metal strap (Fig. 9). As the grid reverses and starts to move inward, a metal trigger

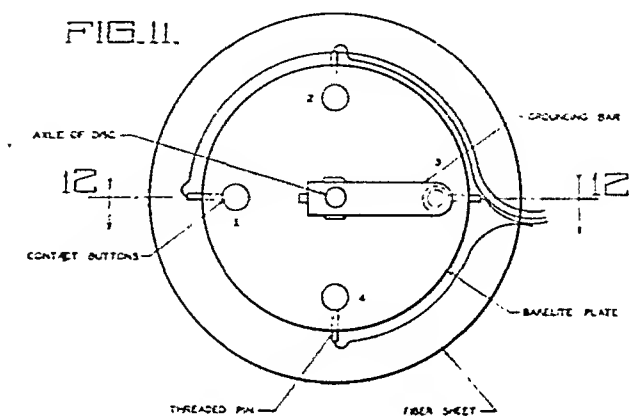


FIG. 12.

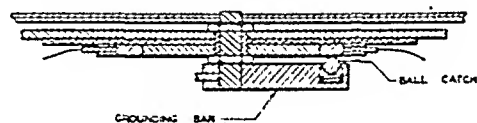


FIG. 11. Detail of grounding commutator viewed from below.

FIG. 12. Section through disc, axle, bushing, and grounding commutator.

attached to the left-hand thread half-nut momentarily strikes the outer ball catch but passes the inner catch without touching it. On the outward trip the trigger strikes the inner ball catch but passes the outer one. By means of the grid switch and a self-holding relay (Fig. 1), exposures shorter than 0.6 second may be made without grid reversal, whereas longer exposures continue through one or several reversals of the grid. The relay is connected so that one side of its coil receives ground from the grid switch and the other side receives 110 volt A.C.

when the exposure switch is closed. After the exposure switch has been closed there is a momentary delay until the grid begins to travel in a new direction and a pulse of ground comes from the grid switch. A pair of normally open relay contacts provides a self-holding circuit so that once the relay has closed it remains closed as long as the exposure switch is held down, and a second pair of normally open contacts initiates the roentgen-ray exposure.

FIG. 13.

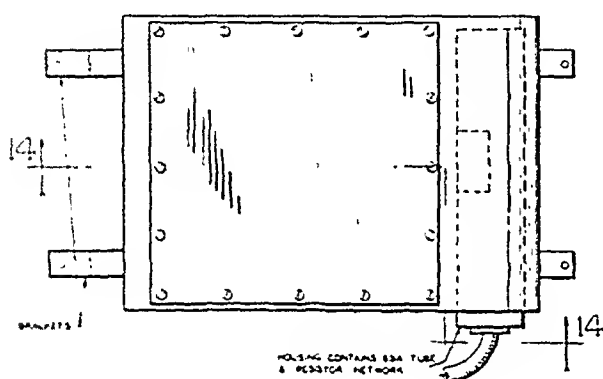


FIG. 14.

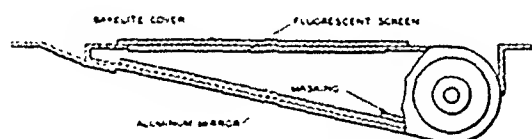


FIG. 13. Detector viewed from above.

FIG. 14. Section through detector to show arrangement of fluorescent screen, aluminum mirror and 913A multiplier phototube.

Originally we placed the reciprocator below the grid in order to keep over-all thickness as small as possible and thus allow the assembly to be used in tilt tables, we have moved the reciprocator to the side of the grid. As presently designed and with the electric motors now available to us, the reciprocator is approximately  $3\frac{1}{2}$  inches thick and, therefore, projects  $\frac{3}{4}$  inch beyond the bottom of the grid. However, the thinnest detector we have been able to devise projects a full inch beyond the bottom of the grid, so nothing would be gained at this

time by further refinement in the design of the reciprocator.

#### CONTROL CHASSIS

A metal cabinet measuring 12 by 12 by  $8\frac{1}{2}$  inches contains the Cramer safety switches, twelve small relays, six pilot lights, six fine and six coarse adjustment potentiometers, together with electronic tubes, transformers, condensers, and the other parts that comprise the circuit shown in Figure 1.\*

*Cramer Safety Switches.* Modern roentgen-ray machines are usually provided with built-in devices that limit the maximum exposure time to one that will be safe for the particular voltage, current and tube that is being employed. Such protection is particularly important with phototimers and in the past we have provided it by means of a valve tube and a condenser circuit.<sup>2</sup> It is simpler, however, to employ motor-driven timing devices such as the Type TD1 manufactured by the R. W. Cramer Company of Centerbrook, Connecticut.

When 110 volts A.C. is supplied to the timer motor, an indicator moves counter-clockwise until it reaches 0, whereupon a pair of normally closed contacts is opened. When the alternating current supply to the motor is broken, the indicator hand resets, the normally closed contacts close, and the timer is ready to operate again. The time elapsing between the energizing of the motor and the breaking of the normally closed contacts is determined by the zero position of the hand which is controlled by a knob on the face of the instrument.

#### OPERATION OF PHOTOTIMER

Let us assume, for example, that the phototimer is to be used with a rotating node tube and a Potter-Bucky grid for Station I (chest) as well as for Station II

\* During the temporary absence of one of us (R. H. M.) for service with the United States Public Health Service, we have had the technical assistance of Harold Ticho, M.S., former member of the electronics staff of the University of Chicago. Mr. Ticho's work on the chassis circuits and the calibration of the detector is hereby acknowledged.



(table) and that the station switch has been thrown to Station II and the disc set for stop No. 3. Under these conditions, relay No. 5 closes because its coil receives ground from commutator button No. 3 and 110 volts from the station switch. Relay No. 5 has three pairs of normally open contacts which now close. One pair lights the pilot for stop No. 3, a second pair completes the ground connection to the 1,000 volt transformer and the operating push button, and the third pair completes the high voltage circuit to the resistor network of the Station II phototube through the potentiometers that have been calibrated for stop No. 3.

When the station switch was thrown to II, the Station II grid was set in motion and current was supplied to the starting mechanism of the rotating anode tube so that as soon as the rotor has been brought up to speed (we use a foot-switch for this), the stage is set for an exposure. When now the operating push button is closed, relay No. 12 is energized and its two normally open contacts close. One pair of these contacts carries no current because the Station I tube is not in circuit but the other pair receives 110 volts A.C. from the starter of the Station II tube and delivers it to one side of the Station II Cramer motor and to one side of the coils of relays No. 7 and 8. Since the Station II grid is now in motion, relays No. 7 and 8 are receiving pulses of ground whenever the grid begins travel in a new direction; and with the first of these pulses following the closing of the operating push button, relays No. 7 and 8 close and the number II Cramer motor starts to run. The closing of the No. 7 contacts provides a permanent ground to relays 7 and 8 and the Cramer motor so that these relays remain closed and this motor continues to run as long as the operating pushbutton is held closed.

Relay No. 8 has three pairs of contacts: one normally closed, two normally open. Opening the normally closed contacts takes the short off the Station II coil, and closing the two pairs of normally open contacts starts the roentgen-ray exposure and

puts the Station II thyatron (IC<sub>21</sub>) in circuit with the coil of relay No. 11. When the thyatron fires, relay No. 11 closes, opening its single pair of normally closed contacts and thus terminating the exposure. If the exposure called for by the phototube is longer than that for which the Cramer safety switch is set, it is the opening of the Cramer contacts rather than the opening of the contacts of relay No. 11 which terminates the exposure.

#### VOLTAGE-COMPENSATING CIRCUIT

This circuit is shown near the lower center of Figure 1. It is arranged so that raising the voltage at the kilovolt meter of the roentgen-ray machine decreases the sensitivity of the phototimer, while lowering that voltage increases its sensitivity, thus compensating for the effect of voltage change on the amount of radiation absorbed by the rear screen, the back of the cassette and the cover of the detector.

#### USE WITHOUT GRIDS AND WITH STATIONARY ANODE TUBES

If either station is to be used without a Potter-Bucky grid, it is necessary merely to provide the appropriate relays with a permanent ground, and if either station is used with a stationary anode rather than a rotating anode tube the appropriate contact of relay No. 12 must be supplied with 110 volts directly from the station switch.

#### CALIBRATION

*Station II, Stop No. 2:* A patient is placed in position for a roentgenogram of the pelvis with stop No. 2 registered in front of the detector and a 14 by 17 inch film in the tray. The machine is set for any desired voltage and current—for example, 70 kv. and 75 ma.—and the number II Cramer switch is set for the maximum safe exposure as determined by the tube manufacturer's chart. The fine adjustment potentiometer for stop No. 2 is set midway between D and L (D for dark, L for light), and by means of a screwdriver the coarse adjustment potentiometer for this stop is

set at its mid point. The rotor of the Station II tube is now started, the operating push-button closed, an exposure made and the film developed for a standard length of time in developer of standard strength and temperature. If the completed roentgenogram is too dark or too light the coarse adjustment potentiometer is turned slightly clockwise toward L or counterclockwise toward D, the process being continued until the desired density is obtained. By similar means the remaining stops of Station II are calibrated—stop No. 1 for knees, stop No. 3 for lateral lumbosacral spine, stop No. 4 for wrists as well as those of Station II, stop No. 1 for frontal chests, stop No. 2 for lateral chests.

It should be the aim to produce roentgenograms of optimum density for all parts when the fine adjustment potentiometers are at their central points, but to compensate for individual preference as to film

density and for minor variation in darkroom technique and in film speed the operator may rotate the fine adjustment potentiometers toward D or L.

When maximum rotation of the fine adjustment potentiometers fails to bring roentgenograms within the desired density range, it is well to check darkroom conditions and the circuits in the chassis before changing the coarse adjustment potentiometers.

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## EVALUATION OF ROENTGEN THERAPY IN FILARIASIS\*

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FILARIASIS has assumed military and naval importance because it has interfered with the efficiency of our armed forces. Because of the chronicity of this disease and its resistance to treatment, it has challenged the skill of the doctors responsible for the health of these patients. Since recent reports have encouraged the use of roentgen rays in treating filariasis, we decided to try to establish the value of this treatment.

The purpose of this paper is to evaluate the results of roentgen therapy in filariasis by comparing the course of the disease in a group of 50 patients treated by roentgen rays with that of an untreated group of the same number.

Dickson, Huntington and Eichold<sup>3</sup> were the members of a Filariasis Board created by the Commanding General of the Defense Force, Samoan Group. Their preliminary report states that the lymphangitis of suspected filarial origin in Samoa was seen after only five months or more of duty in that area. The lesions usually started with the lymphadenitis, and then continued as a retrograde or centrifugal lymphangitis. There was a highly characteristic scrotal involvement (Fig. 1) with funiculitis. No cutaneous or urethral infection was seen. There was a tendency to multiple involvement and recurrence. The constitutional symptoms were mild, usually consisting of a little fever, headache, mental sluggishness, anorexia, nervousness, fatigability, and pain in the areas of lymphadenopathy.

In a later report by Huntington, Fogel, Eichold and Dickson,<sup>5</sup> they state that filaria among American Troops in a South Pacific Island group resembled the clinical entity described by Buxton in 1928 for

which he used the native term *mumu*. This disease occurred in Europeans within a few months of their arrival in a filarial region.

It has been established that the observed lesions are caused by *Wuchereria bancrofti*. Filariasis is a nematode infection which is present in tropical and semitropical areas of



FIG. 1. Showing characteristic scrotal involvement.

the world. The Samoan variety occurring in our troops lacks the nocturnal periodicity of microfilariae. In endemic areas where large masses of the native population are infected, the microfilariae may frequently be demonstrated in the blood. One of our patients who was admitted after this study was concluded showed evidence of microfilariae in his blood (Fig. 2). This twenty-two year old male was a native of the Virgin Islands and had probably had *mumu* since the age of five years. He enlisted in the United States Navy several years ago. He was the first filariasis patient with a positive blood smear so far admitted to our hospital. In lymph nodes removed from some of our Service men, Michael<sup>6</sup> has demonstrated the adult female pregnant *Wuchereria bancrofti*. Man is the definitive

\* Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24-29, 1944.

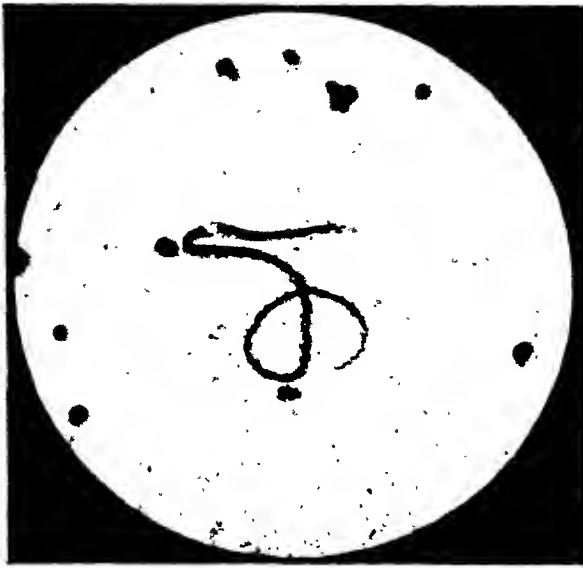


FIG. 2. Photomicrograph showing microfilaria and its fine capsule as seen in a blood smear. This was found in the blood of our twenty-two year old patient who was a native of the Virgin Islands. Note the erythrocytes and leukocytes surrounding the microfilaria.

host and approximately forty-four different mosquitoes may serve as the intermediate host for the development of the mature larvae. Since the circulating blood of those affected, with only the exception of the aforementioned patient, did not show microfilariae, the possibility of transmission of the disease after the patients' return to the United States is thought to be nil. The symptom-free period may vary from two to twelve months. On the average, the first symptoms appear seven to nine months following exposure.

#### ROENTGEN TREATMENT

The evaluation of any form of therapy for filariasis is uncertain and difficult because the disease is characterized by spontaneous remissions and exacerbations. It is a subacute and relapsing disease in which the constitutional symptoms form a major part of the clinical picture. We must therefore rely on the patient's story to some extent in evaluating the results of treatment.

Adams<sup>1</sup> in 1908 reported a good result following roentgen treatment in a case of elephantiasis arabum of the upper eyelid

of five years' duration. Marked improvement was noted after five roentgen treatments. Other types of therapy had previously been unsuccessful. This patient received a total of twenty-three roentgen treatments. The dosage is not stated except in duration of treatment.

Mitra<sup>7</sup> in 1930 recorded the improvement of an area of chronic brawny swelling on the dorsum of the hand and wrist in a patient with microfilariae in the blood after a series of eight roentgen treatments. These were given over a period of four months. There was no recurrence after six months.

Golden and O'Connor<sup>4</sup> in 1934 made the first comprehensive report of the roentgen treatment of filarial lymphangitis and adenitis. Fifteen unselected cases were given roentgen irradiation over the involved extremity and were followed for eight months to three and one-half years after the first treatment. Eight of these patients appeared to be somewhat improved. In 5, the observed changes were too uncertain to permit judgment, and in 2 patients there was no change in the succession of attacks. In only 1 patient was the size of the enlarged gland reduced.

Their dosage varied. Some patients were treated with 180 kv., with a filter of 0.5 mm. copper; 50 to 75 r was given per sitting every week or every two weeks for four treatments. Others were treated with 130 kv. and a filter of 3 mm. of aluminum, giving 100 r over one field per sitting. When the extremity was cross-fired, half the dose was given on one side and half on the other. Occasionally these authors observed an abortive attack immediately after roentgen treatment, but as the treatment continued the reactions became less marked and finally ceased. Histological sections of irradiated tissues containing worms showed more numerous giant cells in their vicinity. These worms were surrounded by marked round cell infiltration and by fibroblasts, in contrast to slight round cell infiltration and areas of hyalinization about the worms in the sections of unirradiated tissues.

Burhans, Camp, Butt and Cragg<sup>2</sup> more recently treated a group of Navy and Marine patients by roentgen irradiation. Their preliminary report in February, 1944, shows that the results of this treatment are encouraging. Their study does not include a control group of patients. These authors selected patients who had bilateral lymph node involvement and administered roentgen treatment only to one side. This allowed for the untreated side to be observed as the control. They put their patients on outdoor duty after the roentgen treatment to observe the effect of roentgen irradiation on any possible recurrence. They report that after a period of observation these patients developed recurrences on the untreated side and that the disease on the treated side was reduced or did not recur at all. The treatment factors were: 140 kv., 15 ma., 50 cm. target-skin distance, filtration of 1 mm. aluminum and 0.25 mm. of copper; 105 r was given every other day until a dosage of 315 r (including back-scatter) to each area was reached.

*Material.* All patients included in our study were referred for treatment from the Tropical Disease Section of the hospital.



FIG. 3. Roentgenogram of the chest (August 2, 1943) of a patient with filariasis complaining of chest pain. Note patchy and confluent densities at the right costophrenic angle and accentuated left perihilar markings.

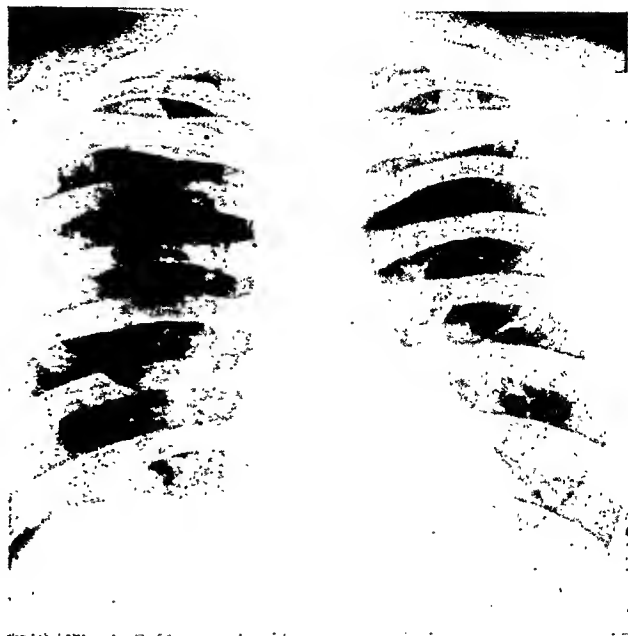


FIG. 4. Roentgenogram of the chest of the same patient (September 1, 1943) one month later showing a shift of the density at the right base to a position above the mid portion of the right diaphragm. A zone of increased density is also noted at the base of the right upper lobe.

The diagnosis was established according to the criteria reported by Dickson and his board. Alternate cases were designated as controls and only myself and my assistant knew which patients were actually receiving the treatment. All the patients were under the impression that they were being treated and all were placed under the machine. In the control group the roentgen-ray beam was not used. The referring physicians were asked to make periodic examinations and to record their findings. The patients were all questioned and examined before each roentgen treatment and at weekly intervals after treatment. The findings were carefully recorded.

These patients were white males of the Navy and Marine Corps between the ages of nineteen and thirty-six years who had been sent to the hospital from a South Pacific group. The average time between exposure to the disease and the onset of symptoms was nine months.

The symptoms were tiredness, nervousness, painful glandular swellings, headache, loss of appetite, photophobia and mental sluggishness.



FIG. 5. Roentgenogram of the chest of the same patient (September 6, 1943) five days later shows partial clearing of both densities in the right lung and accentuated pulmonary markings at the base of the left upper lobe.

Some of these patients complained of a pleuritic type of chest pain. Roentgenoscopic and roentgenographic examination

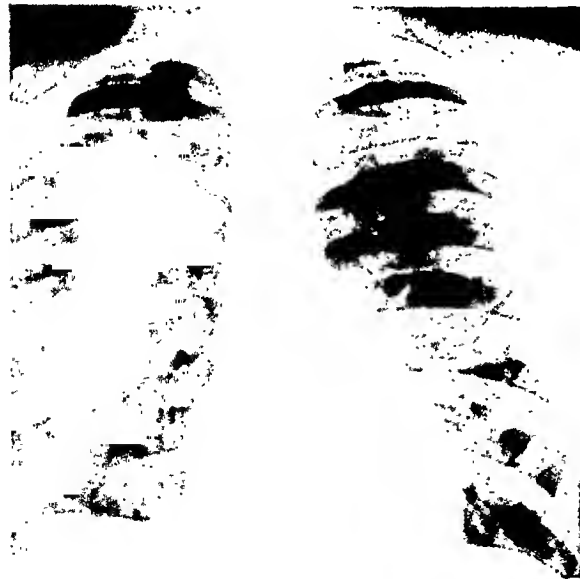


FIG. 6. Roentgenogram of the chest of the same patient (September 13, 1943) six weeks after the first study shows a small patchy density in the right cardiophrenic angle, clearing of the density in the right upper lobe and accentuation of the left hilar shadow and perihilar markings.

of the chest (Fig. 3, 4, 5, 6 and 7) showed a patchy type of parenchymal infiltration as evidenced by a mottled increased density affecting one or more lobes of one or both lungs. These areas cleared spontaneously in one lobe only to reappear in another lobe of the same lung or in the opposite lung. There were none of the signs or symptoms which usually accompany an atypical pneumonia. The patients were afebrile and the blood counts were within normal limits. The lesions were observed over a period of

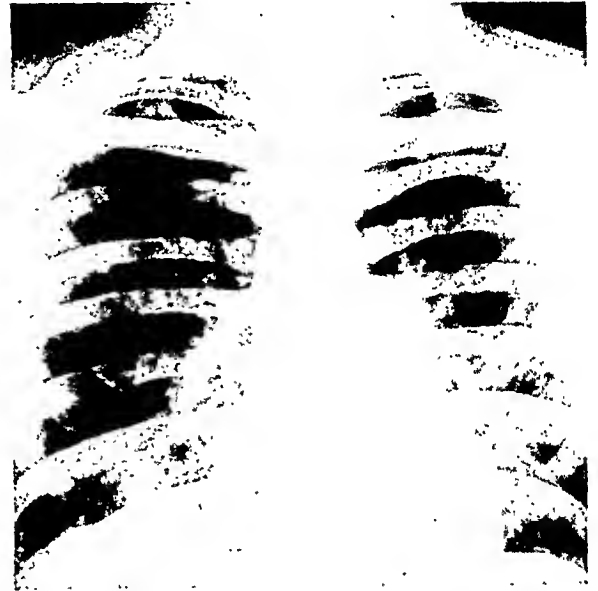


FIG. 7. Roentgenogram of the chest of the same patient (September 27, 1943) almost two months after the first study shows a more pronounced patchy and confluent increased density in the right cardiophrenic angle and more marked peribronchial infiltration adjacent to the left heart border.

months. One area would clear in several weeks while others would persist for months. While one area cleared, a new area in another lobe might appear. None of these patients were acutely ill at any time.

The physical signs were multiple cervical, axillary, epitrochlear and inguinal adenopathies, usually tender on palpation and measuring 0.5 to 2 cm. in diameter. Other signs were a thickened epididymis, enlarged testicles, hydrocele and varicocele. Occasionally a thickened cord-like struc-

ture was palpable in the soft tissues of the extremity. True red streaks on the extremities were rarely seen. Edema of the forehead and face and moderately swollen extremities were sometimes observed. No cases of true elephantiasis were seen. All of these patients represented very early cases of filariasis. Only a few had a low grade fever. All were ambulatory, well nourished and did not appear acutely ill. Blood smears during the day and night showed no evidence of microfilariae.

The treatment consisted of both intermediate and deep roentgen therapy ranging from 135 to 250 kv., 15 ma., 50 cm. target-skin distance, and 0.5 mm. copper plus 1 mm. aluminum filter. The treatment was directed to the areas of adenopathy and/or to the areas of localized swelling of the extremities. The size of the field was usually 10 by 15 cm. over the gland-bearing areas, such as the axillary, inguinal, and femoral fields. The epitrochlear areas treated were usually 6 by 8 cm. in size. In addition, we gave a course of treatment to some patients over the hypogastric gland areas through a 15 by 20 cm. lower anterior abdominal field.

The dosage was 150 r, measured in air, given to one area every two days for three treatments until each area received 450 r.

Since some authors believe that the adenitis and lymphangitis are local manifestations of an allergic response to the worm protein, another group of patients was given total body irradiation in an attempt to determine the effect of roentgen rays on the total organism. The factors for this treatment were: 250 kv., 15 ma., 135 cm. target-skin distance, and 0.5 mm. copper plus 1 mm. aluminum filter; 10 r, measured in air, was given to each of two anterior fields and two posterior fields per sitting which together covered all of the body except the head. Three such treatments were given at intervals of two days. The blood count was checked before each treatment and only a few patients showed a slight leukopenia. In these, the treatment was postponed for several days until their white

blood count returned to a normal level. The response to the total body irradiation was similar to that observed after the administration of local therapy except that the glandular swellings did not regress as markedly.

It was interesting to note that there was a marked psychic factor in the patients' evaluation of the treatment. Several patients who were placed under the roentgen machine as controls reported that their symptoms were aggravated by the "treatment." They thought their glands were more painful and larger and that their headaches were more frequent and more severe. Some complained of nausea. A few of the patients who were actually treated had similar complaints. In 1 patient, there was a noticeable enlargement of his inguinal glands after the first treatment but no flare-up occurred after the second and third treatments. This patient had the most marked regression of his adenopathy following completion of treatment. Golden and O'Connor report a similar experience in 1 of their cases.

The patients were examined at weekly intervals after the completion of treatment for a period of six to eight weeks and then at monthly intervals whenever possible. Many continued to have some complaints. A few thought they felt better and had less pain. Some thought that they were less sluggish and felt brighter. These changes were noted by patients in both the treated and untreated groups.

Most of the patients in this study have been followed for a total of three to four months after treatment.

*Results.* About 19 to 20 per cent of the patients treated by roentgen rays now are free of disease. A slightly higher percentage of the untreated or control group are free of disease as determined by physical examination. One must conclude therefore that the disease as a whole is not materially affected by roentgen therapy as observed three to four months after treatment. We did observe some beneficial effect in reducing the size of the enlarged lymph nodes and re-



lieving some of the pain which accompanies these glandular swellings. There were no cases of suppurative adenitis in this series.

Our experience with the roentgen treatment of this group of 50 patients suffering from filariasis is not as encouraging as that reported by other authors. A subsequent detailed follow-up study of all patients in this series will be made and reported about one year after the completion of roentgen therapy. Roentgen treatment did not influence the chronicity of the disease nor did it affect the frequency or severity of the periods of exacerbation following the periods of remission.

#### CONCLUSIONS

1. The course of filariasis as observed in 50 patients treated by roentgen irradiation and in 50 untreated patients is similar when examined three to four months after treatment.

2. Several patients have derived benefit from roentgen therapy in that some glandular swellings were reduced in size and were rendered less painful.

3. No harmful effects were observed as a result of this roentgen treatment.

4. Total body irradiation offers no advantage over local roentgen therapy, and at times does not appear to be as effective in relieving the pain of enlarged glands or in reducing their size.

5. Roentgen therapy did not influence the frequency, duration, or severity of recurrent attacks after periods of remission.

6. The roentgen appearance of the chest of several patients who complained of a pleuritic type of pain is presented. The lesions found were a transitory and migrating type of chronic pneumonitis affecting one or both lungs. These patients were afebrile and showed a normal white blood cell count.

7. A further follow-up study will be made one year after the completion of roentgen treatment.

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#### DISCUSSION

COLONEL A. A. DE LORIMIER, M.C., Memphis, Tennessee. It is my understanding that I was named to start this discussion as an Army representative—possibly because it was thought that Dr. Jaffe, representing the Navy, was going to be overenthusiastic about his results. However, he wasn't so very enthusiastic and perhaps there is no reason for my discussion.

Theoretically there might be three means by which radiation therapy might obtain results in the treatment of filariasis. It might sterilize the parasite and thereby minimize the task of destruction of all contained. It might directly destroy the parasite, or it might intensify reaction on the part of human tissues.

Of these three possibilities, it would seem that the first two can be dismissed almost immediately. The parasites are prone to circulate or at least migrate. Therefore, local treatment cannot be expected to sterilize or destroy all of them.

Dr. Jaffe applied the total body irradiation in small dosages, seemingly too small to destroy these organisms and likely too small to sterilize them. Still, he was rightfully apprehensive about white blood cell depletion of the patient.

Thus we are left to consider the practicality of roentgen therapy directed for tissue reaction. The observations of Dr. Jaffe as well as those by Golden and O'Connor and by Burhans and his co-workers are not encouraging but they

are no more discouraging than are the observations following medicinal treatment. Apparently we have no satisfactory regimen for medical treatment of this disease.

With rest and ideal hygienic conditions, the organisms eventually die and become calcified.

As mentioned by Dr. Jaffe, it is possible that the mumu stage of this condition—the lymphadenitis and lymphangitis—is of an allergic nature. It is not satisfying to hear discouraging comments such as we have heard. However, we must know of our limitations.

Certainly Dr. Jaffe is to be congratulated for his scientific approach to this study and for his straightforward thinking and advice.

It is quite likely that all of us in the future will be seeing cases of this sort as our service personnel return from filariasis infested regions—the islands in the Pacific, Africa, India and South China.

We must not speak too enthusiastically as to the possibility of the benefits of roentgen irradiation, of course.

I would be very eager to hear further comments from Dr. Golden.

DR. ROSS GOLDEN, New York. I wish to compliment Dr. Jaffe highly on his very careful, unbiased and scientific approach to the problem. It is quite apparent, however, that his cases were in quite a different stage of the disease from those we saw.

The late Dr. Francis W. O'Connor, Professor of Tropical Medicine, College of Physicians and Surgeons, spent a number of years in the South Pacific studying filariasis. What little I know about filariasis I learned by word of mouth from him. As you know, when these parasites die, some of them become calcified and the shadows of the calcified dead organisms can be shown in the subcutaneous tissues of the lesion, in the popliteal lymph nodes and in the scrotum. O'Connor, Auchincloss and I published a paper in 1930 on the demonstration of calcified filariae. It would be very interesting if Dr. Jaffe and his co-workers in the Navy could follow the evolution of these organisms, to see when this calcification can be demonstrated. Dr. O'Connor thought that this is a helpful diagnostic measure in some cases.

When an infected mosquito bites its victim, the organisms drop off the mosquito's snout and go through the skin into the subcutaneous tissue. Many of them stay in the subcutaneous tissue and develop into adult worms which are

4 or 5 inches long and which look like a dirty linen thread. Some of the organisms get into the lymphatics and may be stopped in the popliteal or inguinal lymph nodes.

In the West Indies and in some parts of the world the mosquitoes which carry this infection are low fliers; that is, they fly close to the ground and therefore they bite the ankles. When a man squats down they may bite and infect his scrotum and thus he may get scrotal elephantiasis.

In other parts of the world they fly higher and bite the arms. *Filaria loa*, endemic in Africa, is usually seen in the arms. We treated 3 such cases.

The victim of filariasis may have no symptoms or very minimal symptoms for some time, and then attacks of what is known as filarial lymphangitis occur. They usually begin in one spot which O'Connor used to call the focal spot. It may be on the leg, it may be in the groin, it is sometimes in the scrotum. A red spot appears with local pain; the redness rapidly extends up and down the leg; the patient has violent constitutional symptoms, vomiting, high fever, generalized pain; sometimes even unconsciousness. We had one patient who spent three weeks out of every month in bed on account of these constitutional symptoms resulting from filarial lymphangitis.

O'Connor found that sometimes the recurrence of these attacks of filarial lymphangitis could be stopped by excising the focal point and in that focal point he would invariably find a live worm. In 1928, he asked whether roentgen treatment might possibly alleviate this condition by interrupting the sequence of these attacks. He believed it was worth trying as nothing else could be offered except excision of a focal point in an occasional case, or an extensive resection of the subcutaneous tissues in elephantiasis. He also wondered whether the elephantiasis might be reduced, which actually occurred in only one of our cases. He inquired also about trying roentgen therapy in chyluria. This led to the treatment of the series of cases which Dr. Jaffe recounted. Since O'Connor's untimely death about five or six years ago, we have had no additional cases, as he was the attraction which brought these patients to the hospital. It should be emphasized that our cases had the disease for many years at the time we saw them and most of them had a marked enlargement of the legs. In thinking of the

roentgen treatment of this condition, it must be borne in mind that the organisms in the blood are microfilariae, which are the offspring of the adult worms and have nothing to do with the symptoms. The adult worms lie in the subcutaneous tissues of the legs and in the lymphatics. Patients may have violent filarial lymphangitis without having microfilariae in the blood.

Two theories in regard to these filarial attacks are held. One has already been mentioned, that is, that the disturbance is a sort of allergic reaction. It was O'Connor's opinion that the attacks were caused by the worm itself. The other opinion, emphatically supported by some workers, is that the attack results from a secondary infection. In favor of that theory are the results of some experiments done by Homans and Drinker in Boston. They produced elephantiasis in dogs' legs by injecting silicates into the lymphatics. Some of those dogs with enlarged legs got attacks similar to filarial lymphangitis. It is my impression that the prevailing opinion now is that the attacks are caused by the worm.

In many cases the sequence of attacks is interrupted when the patient goes from a hot to a cold climate. On the contrary, we had one patient in whom the reverse occurred. He got the infection in Africa. At his home in Canada, when the temperature got low he would have an attack. The series of roentgen treatments he received seemed to interrupt them. He then got along for at least a couple of winters without attacks.

We had some cases in which chyluria stopped following roentgen treatment. I do not know whether the roentgen treatments were responsible or not, but the coincidence was quite definite, and seemed to make the treatments worth while. In these cases I believe it is worth while to try the treatment of the kidney and, if cystoscopy shows enlarged lymphatics in the bladder wall, to include the bladder region.

In the chronic cases with recurring lymphangitis, there is little to offer the patient unless the new bactericidal drugs may be found effective. It seems to me worth while to try roentgen treatment with particular attention to the focal spot.

Again I wish to compliment Dr. Jaffe and to express the hope that the medical officers of the Army and Navy will seize this opportunity to continue the study of this very peculiar disease.

LIEUTENANT JAFFE (closing). I want to thank Colonel de Lorimier and Dr. Golden for their kind remarks and very fine discussion.

The mental attitude of patients with filariasis is important. These boys are depressed and worried about their future. They have heard stories about elephantiasis developing in later life and fear that their testicular swelling may lead to impotency. These findings have not been observed to date and it is possible that the early cases of filariasis may recover completely without sequelae or complications.

The Navy has found that these patients who are ambulatory and not acutely ill do better when given some form of duty. Their mental attitude improves when they are treated as normal people rather than patients. A camp has been established where the filariasis cases are given light duty and are grouped together for further study and treatment. Civilian as well as military and naval physicians should encourage these patients and not be too pessimistic about their ultimate recovery.

We kept the dosage for the total body irradiation low because we did not find microfilariae in the circulating blood and therefore had no reason to employ larger doses.

Dr. Allen of Kansas City suggests that the lung changes observed in our patients may be similar to Loeffler's syndrome which is an allergic manifestation of intestinal parasites causing a transitory parenchymal infiltration of the lungs.



# DIRECT AND INDIRECT RADIOTHERAPY\*†

By B. GRYNKRAUT (of Warsaw)

*Doctor of the University of Paris*

SINCE 1929 when I worked out and published the actinic theory of cancer<sup>1,2,3</sup> I have been able to verify it by many experiments and in this way to bring about a certain amount of progress in the treatment of malignant tumors. I was led to develop this theory by the difficulties of the radiotherapist who has to deal sometimes with tumors that are radiosensitive and disappear readily under the action of radiotherapy, and sometimes with radioresistant tumors, which are less sensitive to roentgen rays or radium and who cannot find any sufficient reasons to account for this difference. Since the chemical composition of radiosensitive and radioresistant tissue is the same, there is no valid reason why roentgen rays should behave especially differently in the two cases. The solution of the problem is not advanced by invoking the physical phenomena which accompany the bundle of rays on its passage through the tissue, as the same phenomena are seen in both cases. Whether it is a radiosensitive or a radioresistant tissue, the roentgen ray which strikes an atom of tissue produces secondary rays, the wavelength of which is generally greater than that of the incident ray, and detaches electric particles from the atom, electrons called recoil electrons (Compton effect). At the same time the effects of ionization are observed. It might be possible to find in these facts a physical explanation of radiosensitiveness, except that unfortunately these phenomena are seen in radiosensitive as well as radioresistant tissues, absorption being the same in the two cases and depending only on the physical condition and chemical composition of the tissue traversed. Therefore we must have recourse to other properties of

the atom and of the radiation which have unfortunately been neglected, and which I have tried to bring to light in the actinic theory of cancer.

One of the fundamental properties of light, of which roentgen rays are only a variant, is that they are disseminated in a straight line and perpendicular to this direction, following the vibrations of electromagnetic waves. In order to accomplish any work, this vibratory energy must be absorbed and assimilated. Now, one necessary preliminary condition to the absorption of vibratory energy is to encounter resonance in the system of the irradiated atom: the atom must vibrate in unison with the light. Just as a given sound can only make a single cord in a piano vibrate, though it strikes many cords all of the same chemical composition and which vary only in their respective lengths, so a wavelength, a quality of a light wave which represents a definite number of electromagnetic vibrations, produces resonance only in those atoms which vibrate easily in unison with this number of vibrations. Therefore in order for the luminous energy of the roentgen rays to accomplish a definite useful work they must fulfill a certain preliminary condition. This condition is fulfilled when the number of vibrations of the roentgen ray which strikes the cell is able to produce in the cell nucleus, in its chromatic network and its achromatic bundles, the phenomenon of resonance: the cell is then said to be radiosensitive. This phenomenon of resonance is accompanied by another phenomenon, that of fluorescence. The emission of a light with a resonance of a greater wavelength than the incident radiation is the characteristic phenomenon of

\* The experimental and clinical part of this work was carried out in the following institutions: Histological Institute of the University of Warsaw, Director Prof. Konopacki; Central Institute of Radiology of the Infant Jesus Hospital at Warsaw; Director Dr. J. Sitkowski. Private Institute of Radiology of B. Grynkrut at Warsaw. At present it is being done in Rio de Janeiro, Brazil, where the work was presented as a lesson in a course on oncology; This lesson was given by Prof. Manoel de Abreu.

† Translated from the French by Audrey G. Morgan, M.D., Medford, Oregon.

fluorescence. This phenomenon is accompanied by the absorption of an atom of oxygen. Therefore, in the last analysis the anaerobic mode of life of the radiosensitive cancer cell is struck by the phenomenon of oxidation. We may say, therefore, that resonance and fluorescence form the essential mechanism of the adaptation of the number of light vibrations to a special condition in which it becomes assimilable by the cell nucleus. This luminous energy assimilated and absorbed by the cell is without doubt mitogenetic in nature, that is to say it is able to stimulate the phenomenon of karyokinesis. The mitogenetic light described by Alexander and Lydia Gurwitsch of Moscow is found in the ultraviolet part of the spectrum and is emitted by cells which are undergoing division. It produces, accelerates and destroys karyokinesis. Between the wavelength of a radiation emitted below 200 kilovolts and that of ultraviolet light what a long distance to travel, how many changes to undergo before being able to act on a cell! We may call these substances which transform light by fluorescence sensitizing substances. We find similar substances in the photographic plate and they are the ones which make instantaneous roentgenography possible by better utilization of the light. The presence of such substances *around* the cells would make the cells radiosensitive and their absence would make them radioresistant. I emphasize the word "around" for these substances are necessarily pericellular, as the quality of radiosensitivity is not inherent in the cell. As a matter of fact,

(a) Any cell cultivated outside the body becomes radioresistant. A tissue culture only becomes sterile (its nuclei not being able to divide, though the protoplasm can breathe and be nourished) with a single dose of 25,000 r of very hard or very soft rays<sup>6</sup> while the organism from which the tissue came can be killed by a much lower dose. A single dose of 1,080 r kills a young rat twenty days old in six days (Grynkrant and Flaks<sup>7</sup>) or a dose of 1,500 r kills an

adult rabbit in eight days (Grynkrant and Sitkowski<sup>7</sup>).

(b) The irradiation of radiosensitive tumors with repeated but insufficient doses makes the tumor radioresistant (Bergonié). And yet the irradiation has not changed the histopathological type of the tumor. What has happened in these cases after repeated irradiations is that the sensitizers to light have been destroyed and it has not been possible to reconstruct them.

(c) Metastases of radiosensitive tumors may become radioresistant or, on the contrary, radioresistant tumors may give rise to radiosensitive metastases. What has changed in these cases has been the external conditions in which the metastatic cells may become radiosensitive if they find radiosensitizing substances.

(d) If the action of roentgen rays in therapeutic doses has to undergo preliminary changes before beginning to act on the cell itself the action is indirect and mediate. We have tried to make this indirect action manifest in the following experiment carried out in collaboration with Flaks.<sup>6</sup> In this experiment, rat A, twenty-five days old, had had a Jensen sarcoma for fourteen days. This tumor was incised twice in two different places, once before irradiation and again after irradiation. On each of these incisions bits of the tumor were removed which were then grafted. The first time the tumor was incised, two particles were removed and each piece was inoculated into the gluteal muscles of a rat seventeen days old—rats No. 1 and 2. The wound was then closed. These were control rats inoculated with non-irradiated grafts. In the second stage the rat A was subjected to general irradiation with a lethal dose of roentgen rays. The rays were only slightly filtered (1 mm. wood) but the radiation was quite penetrating (176 kv., 2 ma.), and the focal distance 30 cm. A dose of 1,080 r was given in twenty minutes. After an hour another incision was made in the same tumor and three grafts removed from another part of it. These fragments

were grafted into the thigh muscles of three fresh rats seventeen days old (No. 3, 4 and 5), and of the same litter as the control rats. These last grafts, therefore, came from a tumor that had been irradiated.

On the twentieth day of the experiment we found that:

- (a) All the grafts without exception took (both the irradiated and the non-irradiated).
- (b) They produced tumors weighing 6 gm., 5 gm. and 8 gm. in the control cases (average 7 gm.) and 8.5 gm., 9 gm. and 13 gm. (average 10 gm.) for the tumors originating from grafts of a tumor that had previously been irradiated with a lethal dose.
- (c) As to macroscopic metastases in the lumbar glands at the bifurcation of the aorta, they were well developed in the rats inoculated with the grafts that had been irradiated previously and were still invisible in the control cases. This experiment was presented before a session of the Society of Biology of Warsaw on March 27, 1936.<sup>8</sup>

TABLE I  
EFFECTS OF AN IRRADIATION ON THE LATER DEVELOPMENT OF A TUMOR OUTSIDE THE BODY

Rat A, 25 days old; initial tumor Jensen's sarcoma 14 days old		
(a) First incision on non-irradiated tumor, 2 rats 17 days old were grafted	Weight of secondary tumor on 20th day	Metastases
Control rat No. 1	6.5 gm.	Absent
Control rat No. 2	8.0 gm.	
(b) Second incision of the same tumor 1 hour after irradiation with a lethal dose		
Rat No. 3	8.5 gm.	Apparent
Rat No. 4	9.0 gm.	
Rat No. 5	13.0 gm.	

As a result of a lethal dose of roentgen rays, the animal survived only a few days and then died. Was the same thing true of the tumor cells which at the time of the irradiation were a part of the body of the rat and which were also subjected to the action of the rays? The answer is No. The

tumor tissue remained insensitive to the irradiation and in a new medium in another rat it developed readily. The action of the rays at this dosage was not direct, as it left the tumor cells intact and capable of later development. The action of the rays in this case was therefore indirect; it was brought about by the intermediation of sensitizers which reduced the light by fluorescence, creating luminescence more capable of being assimilated by the cell nucleus. Thanks to this fact a dose one-twentieth of that necessary for direct action (25,000-r), that is a dose of 1,080 r, was fatal to the body of the rat.

(d) The nature of the indirect dose is shown by the experiments which follow. If the irradiated tumor is left for a long enough time in the body of the irradiated animal, its vitality decreases visibly and the decrease is greater the longer the transfer is delayed.

*Description of the Experiment:*

On January 8, 1938, three rats twenty-five days of age with large tumors (Jensen sarcomas) were irradiated. The weights of the rats including the tumors were at this date for rat C 68 gm., for rat D 90 gm., and for rat E 91 gm.

(1) January 8, 1938. Rat C was killed two hours after irradiation with a lethal dose. The weight of the tumor was 10 gm. Five other rats (weights 100 to 120 gm.) were grafted intramuscularly with bits of this tumor.

(2) January 10, 1938. Rat D was killed forty-eight hours after irradiation with a lethal dose. The weight of the tumor was 9 gm. Bits of this tumor were inoculated into 5 rats (weights 90 to 110 gm.).

(3) January 11, 1938. Rat E was about to die seventy-two hours after irradiation with a lethal dose and was killed. The weight of the tumor was 15 gm. It was inoculated into 5 rats (weights 100 to 110 gm.).

(1) On January 21, 1938, that is thirteen days after being grafted with the tumor of rat C, the 5 rats grafted with it were killed.

The weights of the tumors obtained in this way were 0.7 gm., 0.4 gm., 0.5 gm., 0.65 gm., and 1.2 gm., total weight 3.45 gm.

(2) On January 23, 1938, the 5 rats inoculated with tumor D were killed. The weights of the tumors thirteen days after inoculation were 0.5 gm., 0.9 gm., 0.4 gm., 0.5 gm. and 0.6 gm., total 2.90 gm.

(3) On January 24, 1938, that is thirteen days after having been grafted with the tumor of rat E, the weights of the tumors obtained from the 5 other rats were 0.6 gm., 0.1 gm., 0.2 gm., 0.25 gm., 0.25 gm., total 1.40 gm.

TABLE II

IMPORTANCE OF THE "TIME" FACTOR IN THE INDIRECT ACTION OF ROENTGEN RAYS. THREE RATS WITH LARGE JENSEN SARCOMAS WERE IRRADIATED WITH THE LETHAL DOSE

Rats with primary tumor	Time after irradiation	Weight of primary tumors
C	2 hr.	10 gm.
D	48 hr.	9 gm.
E	72 hr.	15 gm.

Grafted on 5 fresh rats	Date killed	Total weight of secondary tumors
Jan. 8	Jan. 21	3.45 gm.
Jan. 10	Jan. 23	2.90 gm.
Jan. 11	Jan. 24	1.40 gm.

A tumor which remains in an irradiated medium dies there; however, if the medium is changed it may develop later, but only on condition that it has been removed from the first medium soon enough. The sensitizers of the irradiated medium therefore do not adhere to the cell as they do not accompany it into the new medium. The time factor therefore expresses the intensity of the indirect dose.

(c) The effects of indirect irradiation<sup>9</sup> may be studied on young rats fifteen to twenty days old which have been given a single total irradiation. Half of the lethal dose applied in this way allows the animal to survive for quite a long time and causes epilation, profound anemia and atrophy of lymphoid tissue (spleen, lymphatic glands).

From our protocols of 150 animals we have chosen the following example which we will describe in more detail.

This experiment No. 4 dated January 5, 1933, was made on 6 rats of the same litter twenty-three days of age and with an average weight of 18 gm. They were totally irradiated a single time with half the lethal dose. Three days later intramuscular grafts of Jensen sarcoma were made into the muscles of the left thigh. On the same date 6 other rats of the same age and the same litter were inoculated in the same way without preliminary irradiation. They served as controls. At the end of five days the weight of the latter had increased an average of 5 to 6 gm., while the former group had kept their initial weight with almost no increase. At the end of ten days the rats that had been given preliminary irradiation had gained an average of 8 to 10 gm., while the controls had gained 13 to 15 gm. On the twentieth day the experiment was ended and the animals were killed. They were then weighed. It was found that the weight of the irradiated rats was less than that of the controls. As to the weights of the tumors that developed on the irradiated rats (1.5 to 4 gm.) they were less than half those of the controls (5 to 8.5 gm.). At this date metastases were found in the lumbar glands only in the irradiated animals while they were still absent in the controls.

The preliminary irradiation of an animal makes it impossible for a graft to grow in it even three days after the irradiation. The graft finds a resistance in the tumors irradiated three days previously, a resistance which is stronger against the growth of the tumor than against the growth of the body of the young rat. The average weight of the non-irradiated animals on the twentieth day of the experiment was 40 gm., that of the irradiated 30 gm. Therefore the irradiation had caused an arrest of growth of 25 per cent in the rats while it had produced a much more powerful arrest of the growth of the tumors. The total weight of the tumors which had grown on the non-irradiated rats was 29.5 gm., while that of



the tumors which had grown on the irradiated animals was only 11.5 gm. Therefore, while the growth substances of the body had suffered a reduction of 25 per cent, the forces which favored the growth of the tumor had been decreased by 60 per cent. The forces which make a young body grow are therefore different from those that make a tumor grow.

Another conclusion is that prophylactic

can be borne, not because of the superficial action of the slightly penetrating rays, as Chaoul thinks, but because only very small fields are irradiated. I have analyzed these phenomena in several publications.<sup>7,10</sup>

The actinic theory in addition to the time factor shows the importance of the space factor and that the irradiation of a large skin surface means the activation of a larger amount of sensitizers. Mallet uses

TABLE III

EFFECTS OF PROPHYLACTIC IRRADIATION ON THE GROWTH OF YOUNG RATS AND ON THE WEIGHT OF THE TUMORS

Jensen sarcomas were grafted into

(a) Non-irradiated rats

Dates	Jan. 5	Jan. 10	Jan. 15	Jan. 25	Jan. 25	
Rats	Weights				Tumors	Metastases
No. 1	18.5 gm.	24.5 gm.	33.0 gm.	42 gm.	8.0 gm.	absent
No. 2	18.5	24.5	32.0	43	8.0	absent
No. 3	18.5	24.0	32.0	40	8.5	absent
No. 4	19.5	24.5	31.5	35	5.0	absent
No. 5	17.5	23.0	30.5	+	Very small	absent

(b) Irradiated rats

No. I	19.0	20.5	27.0	—	—	absent
No. II	18.5	20.0	28.0	26	3.0 gm.	macroscopic
No. III	18.0	18.0	26.0	—	—	absent
No. IV	18.5	20.5	28.5	33	1.5	absent
No. V	20.0	20.5	27.5	32	4.0	macroscopic
No. VI	16.5	16.0	23.5	24	3.0	macroscopic

Non-irradiated rats: Total weight of tumors obtained 29.5 gm.

Irradiated rats: Total weight of tumors obtained 11.5 gm.

irradiation makes the organism more resistant to tumor growth, but the action of the irradiation must not go so far as to destroy the lymphatic system, as in that case the destroyed glands would become the site of metastases.

In summary, we have looked for and found in our experiments a confirmation of our theory that the tumor cell is in itself radioresistant and becomes radiosensitive only by the pericellular accumulation of substances that are sensitizing to roentgen light. The effects of radiotherapy are indirect, direct effects being manifested only when very large doses are used, such as those used, for example, by Chaoul in his close roentgen therapy. These large doses

this method of irradiating large fields at a long distance in teleradiotherapy to cleanse the organism of the metastatic disseminations of cancer. He has reported a certain number of successes, on condition, however, of using only very small doses, not exceeding a few multiples of 10 r applied at one sitting. It is evident that with this method the action can only be an indirect one. The irradiation of large surfaces cannot be combined with the use of large doses. On the other hand, though the method of using very small surfaces makes it possible to give large doses of roentgen rays, the percentage of depth transmission is negligible in proportion to that obtained by irradiating large skin surfaces. In order to

balance the disadvantages of these two systems, I tried a new solution of the problem and divided the large irradiated field like a checkerboard of small quadrilateral fields 3 by 3 cm. in size, separated by strips of non-irradiated surface covered with lead strips 0.5 cm. wide and 2 mm. in thickness. This can be accomplished easily by taking a sheet of lead 2 mm. thick and making quadrilateral holes 3 by 3 cm. in it and at equal distances of 5 mm. from each other. This grill is fixed to a thin layer of aluminum which is applied directly to the skin. While 1,500 r applied directly without a grill to the abdomen of a rabbit, filtered with 1 mm. aluminum, with 100 kv., or with 1 mm. copper filter and 200 kv., would cause death of the rabbit within eight days, the same dose applied through a grill, and measured under the grill, has no marked effect. Even a double dose of 3,000 r applied all at once through a grill, and measured under the grill, does not cause death until the end of three weeks. Moreover, our experiments show that a so-called "erythema" dose measured under the grill (for the grill partially arrests the rays) and applied to the skin of a man's back on one side, say the right, does not cause the vasomotor phenomena which are seen on the left side where the same dose has been given directly on the skin without the interposition of a grill. The presence of a grill therefore prevents the vasomotor phenomena of erythema, but does not prevent the absorption of the active dose of roentgen rays and therefore makes it possible to increase the intensity of the treatment which is interfered with considerably by the secondary vasomotor phenomena. Similar results have been attained by compression of the skin and by the application of ice which causes anemia of the skin. In our method, the capillary circulation of the skin is kept normal by an entirely different mechanism which we shall describe.

The irradiation of the skin by roentgen rays produces catabolic substances, among them histamine, which must be absolutely eliminated from the irradiated field. This is

easy when the field is only a few square centimeters in size, for the return circulation takes place through the intact capillaries of the non-irradiated field bordering the irradiated surface. But if the same surface is included in a larger field which has also been irradiated intensely, the flow of these catabolic substances through the irradiated portion takes place only with great difficulty. It is easy to prove that the surface bordering this large field is relatively smaller than the surface bordering a small irradiated area. For instance, a surface 1 sq. cm. in area would be surrounded by 8 sq. cm. of non-irradiated surface if the non-irradiated bordering surface is 1 cm. broad. The same width of non-irradiated boundary surface bordering 100 sq. cm. of irradiated area would be only 44 sq. cm. Therefore when the irradiated surface increases from 1 to 100 sq. cm. the bordering surface only increases six times (from 8 to 44 sq. cm.). A large irradiated surface has a relatively small boundary surface and the dose of roentgen rays borne by it would be lower because the flow of vasodilator substances from the erythema takes place with greater difficulty and it is therefore relatively more radiosensitive than a small surface. The grill creates a drainage through a large irradiated field which facilitates the nutrition of the small fields and increases their radioresistance (Fig. 1). We made the following experiment: A grill was placed parallel to and above the photographic film, the distance between them being 10 cm. Roentgenography of the grill showed very definite boundaries on the photographic film. But when water was placed between them instead of air the secondary radiation emitted by the water during roentgenography gave an indistinct and not very clear image. This image corresponded to the deep action of the roentgen rays where there are not as distinct zones of separation between the irradiated and non-irradiated surfaces as on the surface of the skin. The action of the grill is therefore different on the surface of the skin and in the deep tissues: it desensitizes the skin and does not

prevent hyperemia of the tumor, which becomes sensitized to the roentgen rays. I irradiated a large number of these patients by the grill method, in collaboration with Sitkowski; one of these cases was published by us in 1939 in Warsaw. It was that of a young man twenty years of age, cachectic, icteric, with a large hard lobulated tumor in the epigastrium. Exploratory laparotomy showed that it was a tumor of the liver, which was confirmed by histopathological examination. The abdomen was closed and the patient was sent by the surgeon to the roentgen department. We gave the radiation through a grill with excellent results; the tumor disappeared and the patient was able to eat and to move without fatigue.

Summarizing we may differentiate between:

(a) Direct radiotherapy—that in which 25,000 r can be applied at one sitting. It is evident that this technique cannot be realized in practice. Only very small fields can bear very large doses of roentgen rays, as in Chaoul's method.

(b) Indirect therapy is that which applies very low doses to very large surfaces, that is, teleradiotherapy which has a purely humoral action. It is of advantage to give these treatments through a grill.

(c) Mixed radiotherapy is carried out partly by the direct and partly by the indirect method: it is the classical radiotherapy with medium-sized fields. It is necessary, therefore, that an effort be made to increase the sensitizing action of the pericellular substances. This sensitization of the tumor is a problem for future research and should be carried out in conjunction with desensitization of the skin, which can be accomplished by the application of grills with square openings or with parallel slits of the Lysholm type. The other conclusions of the actinic theory of cancer cannot be given here and the reader must be referred to our previous publications.<sup>1,2,3</sup> We may add, however, that the actinic theory of cancer holds that the origin of every cancer cell is to be found in a pathological accumulation of growth substances with a photo-

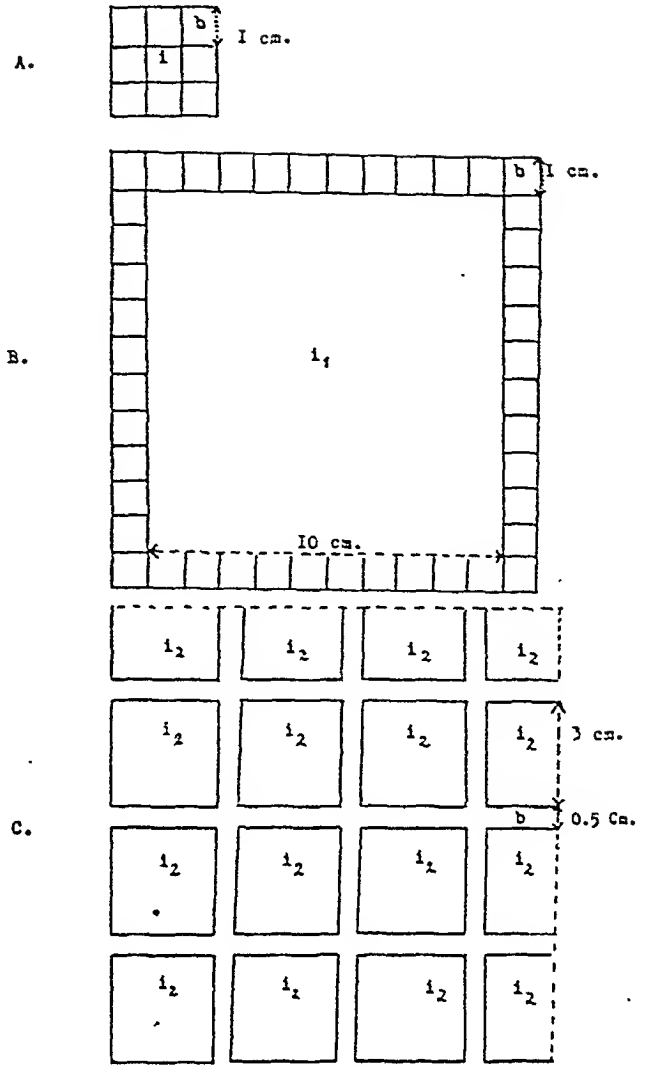


FIG. 1. The respective dimensions of the bordering surface (b) and the irradiated surface (i) (on the assumption that the width of the surface (b) is 1 cm.).

A. Surface (i) = 1 cm.<sup>2</sup> Surface (b) = 8 cm.<sup>2</sup> The proportion  $i:b = 1:8$ .

B. Surface (i<sub>1</sub>) = 10 × 10 or 100 cm.<sup>2</sup>

Surface (b<sub>1</sub>) = 4 × 10 + 4 or 44 cm.<sup>2</sup>

The proportion  $i_1:b_1 = 100:44$ .

Therefore, in increasing the irradiated surface 100 times ( $i:i_1 = 1:100$ ) the bordering surface is only increased six times ( $b:b_1 = 8:44$ ). The bordering surface decreases in proportion as the irradiated surface increases. This results in progressive tolerance of the skin to the rays.

C. On irradiating the same surface of 100 cm.<sup>2</sup> through a grill with quadrilateral openings 3 × 3 cm. in size (9 cm.<sup>2</sup>), the lead strip between which is 0.5 cm. in width, an important bordering surface is created in the interior of the irradiated surface. The bordering surface is increased in this way at the same time with an increase in the tolerance to the roentgen rays.

sensitizing function around a diseased cell. On the other hand, in every precancerous

condition there is an increase of radioactive potassium in the blood and of blood sugar, the oxidation of which is a source of mitogenetic irradiation (Gurwitsch). The cells which are about to become cancerous are subjected to particularly intense irradiation, for they are surrounded by photosensitizing substances, which results in acceleration of the process of division which may become anarchic and tumoral. Solar or roentgen cancers with cholesterol as a sensitizer are produced in this way (Roffo). The origin of the mitogenetic light may therefore be intrinsic or extrinsic. Tar cancer is only a cancer sensitized to tar, as tar, the benzantracenes and the cholanthrenes are fluorescent substances with a spectrum defined by Schrotter. On the other hand, the irradiation of tarred surfaces accelerates the development of experimental cancer.

These ideas have a social application, as the industrial cities where the distillation of coal and benzene are carried on as a source of energy saturate their atmosphere with cancer-producing substances. Statistics are available which show an increase of the general mortality from cancer and from that of cancer of the lung particularly. Industrialization therefore runs parallel with a more intense cancerization. We need only call to mind the aniline factories (for tumors of the bladder) and the radium mines (for tumors of the lung) which by sensitizing certain tissues make them more likely to undergo cancerous changes.

The actinic theory of cancer therefore takes into account both the mechanism of radiotherapy and the origins of cancer.

#### CONCLUSIONS

We have irradiated tumors (Jensen's sarcoma) in young rats, giving them the lethal dose. The dose which was lethal for the animal's body was not so for the tumor cells, as they could be grafted on a fresh rat successfully if they were removed from the original rat in time: the later the grafting was carried out the less the vitality of the graft. On the other hand, preliminary ir-

radiation of a fresh rat rendered it more or less refractory to the graft. As 25,000 r is the dose necessary to arrest proliferation of culture cells, this dose may be considered the direct dose. But it is obvious that 1,080 r (the lethal dose for the rat) cannot represent the dose for direct action, as it is only one-twentieth of the above dose. Its action is therefore indirect and does not decrease the vitality of the tumor immediately but only with the lapse of time. To increase the power of the roentgen rays on indirect action, we must therefore admit the existence of sensitizers which by fluorescence degrade the light and provoke a nuclear response in radiosensitive tissue and the absorption of an atom of oxygen. These premises constitute the basis for the actinic theory of cancer. It follows, therefore, that large surfaces are more radiosensitive than small ones and I have proposed the irradiation of large skin surfaces through the openings in a lead grill. This makes a checkerboard of small surfaces bordered by non-irradiated surfaces. Our experiments on rabbits have proved that the application of the lethal dose (1,500 r) has no effect if it is applied through a grill and that it must be doubled (3,000 r) to have a much less effect (the rabbit does not die until the end of three weeks instead of eight days). I have described three types of radiotherapy:

Direct action—which cannot be practiced on the living body.

Indirect action—irradiation by teleradiotherapy of large surfaces with small doses.

Mixed action—that is, the classical radiotherapy, a combination of direct and indirect.

Emphasis has been placed on the social importance of sensitizers: cancerization develops parallel with industrialization (hydrocarbon wastes of industry).

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# EDITORIAL

## THE NEW ERA IN MEDICINE\*

THIS war has brought a new era in American medicine. In the words of Watson-Jones: "War stimulates progress and particularly the progress of surgery. This has been true throughout all the ages. More suffering has been saved than was inflicted by all the wars of history and the conflict upon which we are now engaged has proved no exception." Stimulated by the war effort and backed by the funds and force of a government at war, the best efforts of our medical schools, hospitals and allied sciences have been focused on medical research to save lives and prevent disease. The increasing tempo of that research has placed medicine decades ahead of its position on September 1, 1939. In the field of military surgery, several theaters of the war report a mortality of less than 1 per cent of those wounded in battle. In every branch of medicine recent chemotherapy has established a new horizon. It has never before been possible for a patient with an advancing double pneumonia, an acute neisserian infection and a positive Wassermann reaction to leave the hospital in a fortnight cured of all three infections. In medicine as well as in surgery more lives will be saved in the near future than have been lost on the field of battle. Also stimulated by the demands of global war from steaming jungles, burning deserts, to arctic ice preventive medicine has reached the highest efficiency in history. Lieutenant General Somervell announced the report at the dedication of the Crile General Hospital: "Not a single American soldier has died of the bubonic plague, not a single American soldier has died of typhus, not a single American soldier has died of cholera or typhoid fever." This is a long way even from the experience of our Span-

ish-American War when more lives were lost from typhoid fever alone than from battle casualties.

These tremendous strides in medical science have been widely publicized. The need of good medical care and energetic health measures has reached a new level in the consciousness of the American public. It is receiving increasing consideration from industry, labor organizations, and from state and federal government. The Administration and the leaders of both political parties are committed to translate the tremendous progress of our wartime medicine and surgery into the health of the nation.

Under stimulus of the war the federal government has entered largely into the field of distribution of medical care. The millions of men and women in the armed services are now and will continue to be entitled to government medicine. The dependents of the Navy enlisted men are entitled to medical treatment and hospitalization. Under the Emergency Maternity and Infant Care Program hundreds of thousands of wives of service men are entitled to pre- and post-natal care with all the expense of delivery and hospitalization defrayed by the federal government. Under the Crippled Children's Act the state and the federal government share equally the expense of the treatment of these patients throughout the nation. In June, 1943, the federal government entered a new and tremendous medical program in the rehabilitation of the physically handicapped. It is estimated that not less than one and a half million persons are entitled to this medical care with a yearly increment of about one hundred thousand cases. The act of 1943 authorized the Federal Security Adminis-

\* Address of the President of the American Roentgen Ray Society delivered at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24-29, 1944.



trator to pay one-half of the expense of corrective surgery and therapeutic treatment necessary to correct or modify a physical condition, which is static, and which constitutes a substantial handicap to employment. The disabled person must show need for such financial assistance, but there is no limit on the type of disability except that it be of such a nature that it can be corrected or modified within a reasonable length of time. Almost any medical, surgical or orthopedic condition can come under this classification, from gallstones or hyperthyroidism to an ununited fracture. Any underprivileged, physically handicapped person in the nation who can be improved or rendered more employable by medical or surgical treatment becomes a subject for this type of federal medicine. Tomorrow Dr. Hilleboe will discuss with you the place of roentgenology in the public health program. He will lay before you the vast government enterprise of case finding in tuberculosis which promises to be universal. The nationwide venereal disease program sponsored by the Public Health Service provides diagnosis and treatment of any case and this product of the war years will also reach millions of patients. All of these projects if not primarily federal medicine are federally controlled on account of financing.

This vast program of federal medicine is at once an opportunity for and a challenge to radiology. The radiologist will welcome the opportunity to serve with his confrères in rehabilitation and in such public health service as proposed by Dr. Hilleboe. We will want to take our place along with the other physicians in this program just as we have done on selective service boards throughout the war and as our members are doing in the armed forces. We will consider this our duty and our privilege.

But there is a challenge in this program of federal medicine which is an important threat to the practice of radiology. Ever since the days of Caldwell and Leonard there has been a continuous struggle to establish and maintain radiology as the practice of medicine. Equal medical training

and experience and equal responsibility have demanded and obtained equal place with other physicians in hospital practice. This relationship has been maintained in the Army and Navy hospitals in the war and its value to the patient and to the organization has been thoroughly demonstrated. But in these new civilian activities of the federal government, such as the Emergency Maternity and Infant Care Program, the Crippled Children's Act and the new rehabilitation program, the government demands that radiology be classed as a hospital service on the same plane as general nursing or the diet kitchen. The requirement is that all service rendered in the hospital including radiology, pathology and anesthesiology, be included and sold on a per diem basis. This edict places the approval of the federal government on those hospitals that have long tried to reduce radiology to a hospital service to be sold along with room and board. The threat arises that this program is crystallizing as a government policy and will cut the pattern for hospital radiology not only in the present civilian programs of the federal government but in all future extensions of federal medicine which may develop under extended social security. Once established, this program is irreversible.

A similar powerful threat to hospital radiology is developing with the widespread hospital insurance plans. Now covering about fifteen million subscribers, several plans include radiology as a hospital service and more are attempting it. While medical men as a whole, including radiologists, welcome prepaid hospitalization, the radiologist maintains that his services under that program are the practice of medicine and like those of his confrères cannot legitimately be sold as hospital care.

The problems of the practice of radiology in the new era of medicine are no longer the problems of the individual. The radiologist is no longer facing his problems of practice with his hospital superintendent and his local board of directors. He is now confronting tremendous forces of federal and state

government and financially powerful hospital associations, many of which question his position and threaten his practice.

If the practice of radiology is to grow and survive as a medical specialty it will require the full force of our united efforts in dealing with these national problems. This does not mean that we must form a labor organization or selfish pressure groups, but it does mean a highly integrated union between all the radiologists in America in matters dealing with public policy. There must be no hesitation and no division in facing these problems as they arise. We must always be ready for prompt, forceful, united, official conferences with government agencies, with the American Medical Association, or with the American Hospital Association. This will require the closest contact between the executive officers of these two scientific societies and those of the American College of Radiology and of the Section of Radiology of the American Medical Association. The committees of all four organizations that have to deal with public relations should be either identical or should be largely overlapping so that every such committee may speak officially for all of radiology including these four organizations. This Joint Meeting and the

two Congresses that have preceded it, in 1933 and in 1937, fully demonstrate that the entire profession of radiology in America can work together cordially and efficiently in their scientific problems. There is every reason to believe that these organizations can work equally well together as a forceful and compact unit in all their public policy relations.

The goal of radiology will always be, as it was in the pioneer days, to become an increasingly vital and integral part of the practice of medicine. The present trend in federal medicine, social security and prepaid hospital plans make the struggle to that end more important than at any time in the past forty-nine years. If we are to promote and preserve radiology as a medical specialty, we must continue that struggle with all the force and energy at our command. Our success will depend largely on the wisdom and foresight of our public policy and upon how firmly we are united in carrying out that policy. But above all, the future of radiology in the new era will, as it always has, depend upon our determination to make ourselves better physicians and to make our work increasingly necessary to the practice of better medicine.

LYELL C. KINNEY



# SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

*Items for this section solicited promptly after the events to which they refer.*

## MEETINGS OF ROENTGEN SOCIETIES\*

### UNITED STATES OF AMERICA

#### AMERICAN ROENTGEN RAY SOCIETY

*Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: 1945, canceled.*

#### AMERICAN COLLEGE OF RADIOLOGY

*Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago.*

#### SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

*Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: 1945, canceled.*

#### ARKANSAS RADIOLOGICAL SOCIETY

*Secretary, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.*

#### RADIOLOGICAL SOCIETY OF NORTH AMERICA

*Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: 1945, to be announced.*

#### RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

*Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.*

#### SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

*Secretary, Dr. Earl R. Miller, University of California Hospital, San Francisco, Calif.*

#### RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

*Secretary, Dr. Max Clinan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.*

#### SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY

*Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.*

#### RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL ASSOCIATION

*Secretary, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.*

#### RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

*Secretary, Dr. Roy G. Giles, Temple, Texas.*

#### BROOKLYN ROENTGEN RAY SOCIETY

*Secretary, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N. Y. Meets monthly on fourth Tuesday, October to April.*

#### BUFFALO RADIOLOGICAL SOCIETY

*Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.*

#### CHICAGO ROENTGEN SOCIETY

*Secretary, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.*

#### CINCINNATI RADIOLOGICAL SOCIETY

*Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.*

#### CLEVELAND RADIOLOGICAL SOCIETY

*Secretary, Dr. D. D. Brannan, 11311 Shaker Blvd., Cleveland 4, Ohio. Meets at 6:30 P.M. at Allerton Hotel on fourth Monday each month, October to April, inclusive.*

#### DALLAS-FORT WORTH ROENTGEN STUDY CLUB

*Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meetings held in Dallas on odd months and in Fort Worth on even months, on third Monday, at 7:30 P.M.*

#### DENVER RADIOLOGICAL CLUB

*Secretary, Dr. A. Page Jackson, Jr., 1012 Tremont Place, Denver, Colo. Meets third Friday of each month at Denver Athletic Club.*

#### DETROIT ROENTGEN RAY AND RADIUM SOCIETY

*Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.*

#### FLORIDA RADIOLOGICAL SOCIETY

*Acting Secretary, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Fla. Meetings in May and November.*

#### GEORGIA RADIOLOGICAL SOCIETY

*Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.*

#### RADIOLOGICAL SOCIETY OF KANSAS CITY

*Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.*

#### ILLINOIS RADIOLOGICAL SOCIETY

*Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.*

#### INDIANA ROENTGEN SOCIETY

*Secretary, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meets annually second Sunday in May.*

#### IOWA X-RAY CLUB

*Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.*

#### KENTUCKY RADIOLOGICAL SOCIETY

*Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.*

#### LONG ISLAND RADIOLOGICAL SOCIETY

*Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.*

#### LOUISIANA RADIOLOGICAL SOCIETY

*Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.*

#### MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

*Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.*

#### MILWAUKEE ROENTGEN RAY SOCIETY

*Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.*

#### MINNESOTA RADIOLOGICAL SOCIETY

*Secretary, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.*

#### NEBRASKA RADIOLOGICAL SOCIETY

*Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.*

#### NEW ENGLAND ROENTGEN RAY SOCIETY

*Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.*

#### NEW HAMPSHIRE ROENTGEN RAY SOCIETY

*Secretary, Dr. Richard C. Barr, Berlin, N. H. Four meetings a year.*

#### RADIOLOGICAL SOCIETY OF NEW JERSEY

*Secretary, Dr. H. R. Brindle, 501 Grand Ave., Asbury Park. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.*

#### NEW YORK ROENTGEN SOCIETY

*Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.*

#### NORTH CAROLINA ROENTGEN RAY SOCIETY

*Secretary, Dr. Major Fleming, Rocky Mount, N. C. An-*

\* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

annual meeting at time and place of State Medical Society.  
Mid-year scientific meeting at place designated.

#### NORTH DAKOTA RADIOLOGICAL SOCIETY

*Secretary*, Dr. L. A. Nash, St. John's Hospital, Fargo.  
Meetings held by announcement.

#### CENTRAL NEW YORK ROENTGEN RAY SOCIETY

*Secretary*, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse.  
Three meetings a year. January, May, November.

#### OHIO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.

#### PACIFIC ROENTGEN SOCIETY

*Secretary*, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

#### PENNSYLVANIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. L. E. Wurster, 416 Pine St., Williamsport.  
Next annual meeting, Hotel William Penn, Pittsburgh, May 5-6, 1945.

#### PHILADELPHIA ROENTGEN RAY SOCIETY

*Secretary*, Dr. R. J. Barden, University Hospital, Meetings first Thursday of each month from October to May inclusive at 7:45 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

#### PITTSBURGH ROENTGEN SOCIETY

*Secretary*, Dr. L. M. J. Freedman, 4800 Friendship Ave. Meets second Wednesday each month, 4:30 P.M., October to June, Pittsburgh Academy of Medicine.

#### ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

*Secretary*, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

#### ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

*Secretary*, Dr. A. M. Popma, 220 N. First St., Boise, Idaho.

#### ST. LOUIS SOCIETY OF RADIOLOGISTS

*Secretary*, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.

#### SAN DIEGO ROENTGEN SOCIETY

*Secretary*, Dr. Henry L. Jaffe, Naval Hospital, Balboa Park, San Diego, Calif. Meets monthly on first Wednesday at dinner.

#### SAN FRANCISCO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Carlton L. Ould, University of California Hospital, San Francisco 22. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

#### SHREVEPORT RADIOLOGICAL CLUB

*Secretary*, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

#### SOUTH CAROLINA X-RAY SOCIETY

*Secretary*, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

#### TENNESSEE RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

#### TEXAS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Asa E. Seeds, Baylor Hospital, Dallas, Texas. Next annual meeting, Temple, Texas, Jan. 17, 1945.

#### UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

#### UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE

*Secretary*, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00-5:00 P.M., Room 301, Service Memorial Institute.

#### VIRGINIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

#### WASHINGTON STATE RADIOLOGICAL SOCIETY

*Secretary*, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

#### X-RAY STUDY CLUB OF SAN FRANCISCO

*Secretary*, Dr. J. M. Robinson, University of California Hospital. Meets monthly, third Thursday evening.

#### CUBA

#### SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA

*President*, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

#### BRITISH EMPIRE

#### BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY

Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

#### SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets on the third Friday of each month at 4:45 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.

#### FACULTY OF RADIOLOGISTS

*Secretary*, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.

#### SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS

*Secretary*, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

#### RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION

*Secretary*, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

#### CANADIAN ASSOCIATION OF RADIOLOGISTS

*Secretary*, Dr. J. W. McKay, 1620 Cedar Ave., Montreal, P. Q.

#### SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

*Secretary*, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

#### RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION

*Secretary*, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

#### SOUTH AMERICA

#### SOCIEDAD ARGENTINA DE RADIOLOGÍA

*Secretary*, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

#### SOCIEDAD PERUANA DE RADIOLOGÍA

*Secretary*, Dr. Victor Giannoni, Apartado, 2306, Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión, Villalta, 218, Lima.

#### CONTINENTAL EUROPE

#### SOCIEDAD ESPANOLA DE RADIOLOGÍA Y ELECTROLOGÍA

*Secretary*, Dr. J. Martín-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

#### SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)

*Secretary* for French language, Dr. A. Grosjean La Chaux de Fonds.

*Secretary* for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.

#### SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

*Secretary*, Dr. Oscar Meller, Str. Banul Mărcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

#### ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

*Secretaries*, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

#### LENINGRAD ROENTGEN RAY SOCIETY

*Secretaries*, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 3 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

#### MOSCOW ROENTGEN RAY SOCIETY

*Secretaries*, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

#### SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

## AMERICAN COLLEGE OF RADIOLOGY

### REPORT OF THE EXECUTIVE SECRETARY

In his excellent book comparing the theories of Oswald Spengler and Raymond Pearl, "Today and Destiny," Edwin F. Dakin expresses a truism that is of particular significance for doctors in these dynamic times: "Any concept--economic, political, or cultural--which leaves its possessor wholly unprepared for tomorrow is of doubtful validity. Conversely, men who are not surprised when the future comes, lie very close to the truth."

President Lowell S. Goin was pleading for a true concept of the future when, in a recent letter to Members and Fellows of the College, he warned of impending social changes that would almost certainly result in new methods of distribution for medical services. He urged radiologists to actively encourage voluntary prepayment plans for medical care, sponsored by medical societies, as the soundest and most desirable method among the many that have been proposed. At the same time, he warned that some form of socialized medicine, embodying compulsory health insurance, is not an inconceivable eventuality.

Doctor Goin's concern would seem to be justified by what most observers have recognized as an increasing pressure of public opinion. The attitude of the public was succinctly expressed by *Fortune* in its December issue: "The state of medicine in the United States is a social problem because the country's conscience has made it so . . . people who cannot find or pay for proper medical care are resentful."

I have been sharply criticized in some quarters for a statement made in my annual report to the Board of Chancellors two years ago in which I referred to the powerful social forces at work throughout the world and their manifestation in agitation for socialized medicine in this country. I remarked that there was a growing conviction among medical men that a head-on

opposition to this unmistakable trend would be as unwise as it would be futile. Subsequent events have proved, I believe, that the demands for improvements in the distribution of medical services must be met, either by voluntary plans for prepayment or, if not, then by compulsory health insurance. It seems unnecessary to recite the extensive evidence that this is so. A half dozen public opinion surveys have revealed a definite public demand for insurance against medical costs.

Brigadier General Fred W. Rankin, in his presidential address before the American Medical Association House of Delegates last year, called upon the medical profession to recognize the gathering momentum of trends that are "directed toward some form of national health service as an integral function of the state." He made a plea that they be regarded not in the light of apostasy, but rather in the light of realism.

Dr. Allan Gregg, whose words carry considerable weight in the medical world, has uttered a similar warning. "The danger for medicine in America lies in failure to acknowledge and to study the sociologic aspects of medicine--the social matrix. We are loath to see that research and teaching, as well as the practice of medicine, will change when change comes in the prevalent interpretations of the role of government and the structure of our society," he says.

It would appear, therefore, that if we are not to be unprepared for tomorrow, we should give consideration in our deliberations to the likely effects of all the various proposals for changes in the economics of medicine. It is a poor general who fails to consider the probable results of every possible contingency that may alter the existing situation.

In our efforts to peer into the future of medical practice in the United States I think we should keep one very important point clearly in mind. It is this: Every system of compulsory health insurance in all the countries of the world has been built upon existing agencies for the distribution

of medical care. On the basis of history, therefore, we can assume that, if a system of compulsory health insurance is adopted by Federal or State governments in this country, existing plans for the application of the insurance principle to payment for medical care would be utilized by the state. The obvious corollary is that medical practitioners would carry on under the state plan much as they did under the voluntary plans which preceded it. This has been almost the universal experience in European systems.

Writing on the "Origins of Health Insurance," in their excellent book on this subject, Simons and Sinai show that compulsory health insurance is built out of three existing institutions: insurance or prepayment plans, the state, and the medical professions. "The relations, reactions, and relative strength of these determine much of the character and results of the operation of existing insurance systems," they say. Their study of compulsory health insurance throughout the world leads them to conclude that pre-existent voluntary prepayment plans have dominated the state systems which followed.

Douglas and Jean Orr, in their book on the British experience with health insurance, point out that the form which the national health system of England finally took was determined by the "friendly societies" which had existed for many years as voluntary plans for prepayment to meet the costs of sickness.

Sir William Beveridge, in his epoch-making report on social insurance in England, observes the part which the voluntary plans have played in setting the pattern of the government system. He contemplates, though with frank displeasure, that they will continue to be utilized as distributing agencies in the expanded system which will undoubtedly be adopted in Great Britain.

He implies, incidentally, as have others before him, that voluntary sickness insurance promotes, rather than deters, the adoption of compulsory systems. In 1909

David Lloyd George pointed to the "friendly societies," which were comparable to our present prepayment plans, as proof of the feasibility and desirability of compulsory sickness insurance. The National Health Insurance Act came three years later. It is significant, perhaps, that efforts to enact compulsory insurance laws in our own country are today most concentrated in the two states with the oldest and largest voluntary medical service plans, California and Michigan.

We all hope that voluntary prepayment plans, sponsored either by medical societies or commercial insurance carriers, will meet the palpable demand of the public for relief from the unpredictable financial burdens of illness. If they do not, the lessons of history teach us that organized medicine has yet another compelling reason for extending these plans as rapidly and as widely as possible. Once firmly established, they would set the pattern and determine the methods to be followed in the event a compulsory system is adopted.

This is a matter of the very greatest importance for the doctors of America. It is surely unnecessary to remark, for instance, that the future of radiology will largely be determined by its status in voluntary prepayment plans, whether or not these plans are later superseded by a compulsory system. Precedents are being established in the experiments by medical societies which demand from the leaders of thought in American medicine the highest order of statesmanship and sound judgment.

Now, in the light of these considerations, the group hospitalization movement, concerning which organized medicine has been exceedingly circumspect, acquires a new importance that tends to justify medicine's diffidence. Are the Blue Cross plans to duplicate the history of England's friendly societies? Two facts lend credence to an assumption that this is altogether possible.

First, a determined effort is being made by directors of Blue Cross plans to extend their benefits to include complete surgical



or medical care. Second, Blue Cross plans would almost certainly be preserved and integrated in a compulsory sickness insurance plan.

The first of these statements will be promptly denied by Blue Cross leaders. But the facts speak for themselves. In Delaware, the Blue Cross plan has already been expanded to include cash benefits for surgical care. It is administered by a Board of Trustees on which there are two hospital representatives for every doctor. Also in West Virginia and North Carolina hospital service plans have assumed full control of medical care plans.

The American Hospital Association, at its recent annual meeting, considered recommendations from several speakers for "extending prepaid hospital plans to cover outpatient care." At the same meeting the Hospital Service Plan Commission approved a proposed model enabling act for comprehensive health service plans which would require, among other things, that any plan incorporated under the act be controlled by a board composed of one-third hospital trustees, one-third doctors, and one-third lay representatives of the public. In the course of the discussions, Mr. Louis H. Pink, president of Associated Hospital Service of New York City, urged expansion of Blue Cross to include the costs of medical care without delay.

In Philadelphia, where the medical society several years ago fought a bitter and unsuccessful battle to exclude radiology and pathology from the hospital service plan, a proposal has very recently been submitted to add complete medical care to Blue Cross benefits. The proponents candidly recommend repeal of the present Pennsylvania enabling act, which requires that a majority of the directors of medical service corporations be doctors of medicine.

Now I desire that I not be misunderstood. Cooperation between hospital service plans and medical or surgical service plans is essential. It is rather generally agreed among hospital leaders that Blue Cross enrollment has about reached its

maximum unless contracts for hospital service can be coupled with insurance against medical costs. There is no doubt that the United States Public Health Service will emphasize this fact in the report of a study it is currently making of the movement. Furthermore, it is both logical and economical to delegate responsibility for sale and routine administration of the medical service plan to existing Blue Cross plans which have several years of experience and have acquired trained personnel.

But, medical societies which turn over complete control of prepaid medical care to Blue Cross plans that are controlled by hospitals are traveling a dangerous road. They are violating one of the basic principles of organized medicine if they fail to establish a separate corporation to control the medical plan, with a board of directors of which at least a majority are doctors.

Ten years ago the American Medical Association laid down the postulate that: "All features of medical service in any method of medical practice should be under the control of the medical profession. No other body or individual is legally or educationally equipped to exercise such control." This principle has lost none of its validity.

If anyone is inclined to minimize the importance of this principle, he has but to follow the course of the controversy that has persisted between hospital service plans and the organized medical profession over the inclusion of certain medical services as a part of hospital care. For ten long years county, state, and national medical organizations have insistently demanded that radiology and pathology be excluded from Blue Cross benefits. Everyone knows that the reaction of hospitals to these unequivocal demands has been one of polite indifference. What makes anyone think they would follow the dictates of the medical profession concerning other branches of medicine, once they were in control of medical service plans?

Constantly during recent years the American College of Radiology has warned that medicine would sacrifice a basic prin-



ciple if it yielded to the adamant demand of hospitals that they be permitted to include radiology and pathology in Blue Cross benefits as a part of hospital care. Too often our admonition that this would open the door to further encroachments by which hospitals would assume added prerogatives in the delivery of medical services has fallen on unheeding ears. Now, as one medical editor has sardonically remarked, "The beans are on the carpet, spread out for all to see."

The second fact stated above, that Blue Cross plans would be integrated in a system of compulsory insurance, is likewise more than a mere assumption. Witness the curious tergiversation that has taken place in Rhode Island. Not long ago the governor of Rhode Island proposed a law for compulsory hospitalization insurance in his state. Promptly Blue Cross executives all over the country assailed the proposal as "un-American" and "regimentation." But, when the governor publicly announced that he contemplated the use of Blue Cross as an agency under the system, opposition quietly died.

The Wagner-Murray-Dingell bill, as you know, authorizes the Surgeon General to "negotiate agreements . . . with private agencies or institutions . . . to utilize their services and facilities . . ." In response to a question from hospital spokesmen, Surgeon General Parran has already expressed the view that this would include Blue Cross plans.

I would point out that this provision in the bill would also permit medical service plans operated by medical societies to enter into contracts for rendering services to beneficiaries. Significant also is the provision in the Wagner bill which permits the practitioners in each area to elect the method by which payment shall be made for services.

Does this not offer sufficient reason for medical societies to set up their own plans for prepaid medical care? Surely the leaders of medicine can see the wisdom of establishing proper precedents now.

Unfortunately for radiologists, all the current problems confronting the private practice of medicine are egregiously manifest in the case of radiology. The threat of compulsory health insurance offers no exception. The future progress and advancement of the science of radiology may very well be determined by the status this specialty is accorded in voluntary plans for prepayment. Thus, the long unhappy fight of the American College of Radiology against the inclusion of medical services as a part of hospital care in group hospitalization assumes added significance.

It is encouraging to note that considerable progress has been made in solving this controversy. In Washington and Iowa, for instance, Blue Cross has agreed to separate radiology from hospital care and to pay cash benefits to the physician for x-ray services. The next step is to transfer these medical benefits from the hospital service plan to the medical service plan, where they belong. This has already been agreed to in New York, where, incidentally, the battle between radiologists and the hospital service plan has been hottest. Last year the Hospital Association of New York State approved a resolution providing that, "In those counties or areas where a Blue Shield Medical Care Plan exists, all prepaid medical and surgical care provided for under any prepaid plan and given through the hospitals or outside of the hospitals should be covered under the Blue Shield Medical Care Plan." The hospital association agreed that when medical service plans were established in areas where they do not now exist, the Blue Cross plan in the community would drop radiology, pathology, anesthesiology, and physiotherapy from its benefits and allow these services to be covered like other medical specialties in the medical service plan. We should offer our commendations to the New York Hospital Association for this splendid step toward solution of a controversy that has unfortunately caused ill feeling on all sides and has undoubtedly retarded the growth of the Blue Cross movement.

Now, then, we have added incentive to continue our endeavors to place radiology on an equal footing with other medical specialties in all plans for prepaid health service. In voluntary plans, the services of a radiologist should be provided like other consultant's services among medical benefits. They should never be included in the per diem paid to hospitals for hospital care. Furthermore, with due respect for the many excellent features of the Blue Cross movement I think we have every reason to raise our voice in opposition to those who would allow the hospital service plans to adopt the role of England's friendly societies by assuming control of medical care plans. There is a place for both, operating in close cooperation but each autonomous in its own field.

Although some of the proposals for compulsory health insurance submitted to Congress in recent years have included radiology among the services to be furnished by hospitals for a specified *der diem*, the Wagner-Murray-Dingell bill provides for separate payment to radiologists. It would be unfortunate if Blue Cross were to establish a different precedent. I believe we are justified in doubting that Blue Cross plans would separate radiology from hospital care if they were permitted to extend their benefits to cover medical or surgical services.

I have attempted here to present a point of view, which I think carries profound consideration for American medicine, and especially for radiology. I have not said that voluntary plans of sickness insurance will be superseded by a compulsory system. I honestly do not believe they will be. But, as my friend A. M. Simons has wisely said, social experiments invariably establish patterns of precedent that are seldom completely reversed. In these dynamic times we have extra reason to be vigilant and to exercise sound judgment in our decisions.

Fortunately for the radiologists of America, an instrument for maintaining vigilance and directing policies on the basis of sound interpretation exists through the American College of Radiology. It provides what former President W. Edward Chamberlain

has referred to as "fire-fighting machinery." Even if the fires cannot always be extinguished, the program of the College keeps them under control and helps to guide the course of future events in a direction least harmful to accepted principles of good radiologic practice.

*Medical Economics*, in a recent article, referred with approval to the aggressive program of the College and observed that it was leading the spearhead of medicine's fight against the tendency for third-party agencies to assume the rôle of distributing agencies for medical services. Said *Medical Economics*: "While the other clinical specialists have a large stake in any such dispute, the radiologists are taking the lead through their vigorous organization, the American College of Radiology."

The reports of the various Commissions and Committees of the Board of Chancellors to be presented at this meeting offer good evidence of the fact that the College is alert, informed, and active, and that it has a positive program for the preservation of essential principles. This program, of course, is not confined solely to socioeconomics. The broad scope of the College program in education, hospital standards, and other activities of the organization are directed toward a single objective: the advancement of the science of radiology and the promotion of its contributions to human welfare.

I am constrained to say again, as I have before, that the Members and Fellows of the American College of Radiology should be grateful to their appointed leaders who direct the affairs of the College for the unselfish effort these individuals are devoting in a cause which they approach with the deepest sincerity. For myself, I am grateful for the continued encouragement and the warm cooperation I have enjoyed from these officers and committee members. I would be ungrateful if I failed to say that I appreciate the confidence you have expressed in permitting me to return to a work for which I too have sincere devotion.

MAC F. CAHAL  
Executive Secretary

### CANCER TEACHING DAY

A Cancer Teaching Day will be held at the Arnot-Ogden Memorial Hospital, Elmira, New York, on Wednesday, May 23, 1945, under the auspices of the Medical Society of the County of Chemung and other sponsoring societies. The meeting will be called to order at 4.30 P.M., and the following papers will be presented:

Hormone Therapy and the Prevention of Gynecologic Malignancies. Clyde L. Randall, M.D., Buffalo, N. Y.

Carcinoma of the Genitourinary Tract. Archie L. Dean, M.D., New York, N. Y.

The evening meeting will be addressed by Cushman D. Haagensen, M.D., New York, N. Y., on the subject of "Diagnosis and Treatment of Breast Cancer."

### CANCER SYMPOSIUM FOR PHYSICIANS

On April 13, 1945, at the Garden City Hotel, Garden City, New York, was held an All-Day Cancer Symposium for Physicians arranged by the Nassau County Cancer Committee with a number of sponsoring organizations. The following program was presented:

Five Years of Cancer Reporting in Nassau. Earle G. Brown, M.D., Mineola, N. Y.

The Diagnostic Problems of Early Cancer.

Lloyd F. Craver, M.D., New York, N. Y.

Cancer of the Genitourinary Tract. Clyde L. Deming, M.D., New Haven, Conn.

Gynecological Cancer. James A. Corscaden, M.D., New York, N. Y.

Physical Basis for the Use of X-Rays and Radium in the Treatment of Cancer. Edith H. Quimby, Sc.D., New York, N. Y.

Cancer of the Breast. Lieut. Commander Charles F. Geschickter, Bethesda, Md.

Gastrointestinal Cancer. George T. Pack, M.D., New York, N. Y.

### RADIOLOGICAL SECTION OF THE LOS ANGELES COUNTY MEDICAL ASSOCIATION

At a meeting of the Radiological Section of the Los Angeles County Medical Association the following officers were elected for the ensuing year: *President*, Dr. Donald R. Laing; *Vice-President*, Dr. Herbert A. Judson; *Secretary*, Dr. Roy W. Johnson; *Treasurer*, Dr. Henry Snure.

### NEW HAMPSHIRE ROENTGEN RAY SOCIETY

At a recent meeting, the radiologists of New Hampshire organized the New Hampshire Roentgen Ray Society and elected the following officers: *President*, Dr. Fred S. Eveleth, Concord, N. H.; *Secretary-Treasurer*, Dr. Richard C. Batt, Berlin, N. H.



## BOOK REVIEWS

*Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.*

**MEDICAL RADIOGRAPHIC TECHNIC.** Prepared by The Technical Service Department of General Electric X-Ray Corporation under the editorial supervision of Glenn W. Files, Director. Cloth. Price, \$6.00. Pp. 365, with 381 illustrations. Springfield, Illinois: Charles C Thomas, 1943.

This book is described as one written by technicians for technicians. However, roentgenologists should not assume that it is therefore of no interest to them, for the better roentgenologists have served an apprenticeship in technique, acquiring by actual experience a knowledge of the problems of their technical assistants and an ability to criticize helpfully, as well as in deprecation of unsatisfactory work. Only thus, can the most satisfactory roentgenologic practice be conducted.

Files and his collaborators have produced a book which is fundamentally practical. Enough of the theory of physics and chemistry is included to provide a basic knowledge of the design, construction and use of roentgen apparatus, sufficient knowledge to enable the technician to pass the examination required for a certificate of registration.

Positioning is adequately covered by the excellent illustrations which make use of the device of photographing a mirror placed alongside of the subject in order to give an additional view and show the centering more exactly. Angles of tilt and shift of the tube are superimposed on the prints. Not all possible variations of positioning could be included in one volume, but those chosen are practical and sufficiently inclusive for most examinations.

The details of procedure as to kilovoltage, variation with part thickness, milliamperes-seconds, and other helpful suggestions, are applicable to various machines to a remarkable degree. Dental technique is illustrated with the more common and, at the same time, more difficult technique, using the horizontal table rather than the special tube and dental chair. This seems a wise choice on the part of the authors.

While plain photography and photography of the fluorescent screen image may not be used by the

average technician, their inclusion in this book is an indication of its scope and completeness.

Medical Radiographic Technic is in its second printing and is no longer an untried project. It has been the privilege of this reviewer to employ it in training of several inexperienced technicians, and the results have exceeded expectations. Since roentgenographic procedures vary with the type of equipment, the needs of the particular case and the personal preferences of the individual, some will find details to criticize. However, a fair and impartial appraisal of the subject matter and its presentation will place this book high on the list of practical books on roentgenographic technique.

E. W. HALL

**PHYSIOLOGY IN AVIATION.** By Chalmers L. Gemmill, B.S., M.D., Commander, MC, USNR; Associate Professor in Physiology, Johns Hopkins University, School of Medicine, Baltimore, Maryland; Instructor in Physiology, School of Aviation Medicine, Naval Air Station, Pensacola, Florida. Cloth. Price, \$2.00. Pp. 129, with 18 illustrations. Springfield, Illinois: Charles C Thomas, 1943.

This handbook, prepared by a former Associate Professor of Physiology in the Johns Hopkins University School of Medicine, and now a Commander in the Navy and Instructor in Physiology, School of Medicine, Naval Air Station, Pensacola, Florida, fills a practical need. It is a concisely presented, authoritative, easily read and understood presentation of the essential facts dealing with the reaction of the body to changes incident to flying at different levels of the atmosphere. Although it was prepared primarily for students of aviation, it should be of interest also to many others, for these days all intelligent persons should have some knowledge of the problems and their solution in this rapidly growing and important field.

Such a book as this may serve the useful purpose of introducing some of the parents of the country to an understanding of environmental changes to which their sons are subjected daily in the course of their duties in the present war. Furthermore, it should evoke their gratitude to

learn of the safeguards that are established by the armed forces in an attempt to overcome the more important hazards of flying.

Several problems incident to the introduction of the modern aeroplane merit special attention. Among the more important are anoxia, the effects of acceleration, and aero-embolism. Anoxia and aero-embolism are not new problems because the effects of the former are familiar to every physician, and the latter has been known to occur in deep sea divers and caisson workers for years. An interest in both conditions, however, has been greatly stimulated by the rapid expansion of aviation.

The problem of acceleration is one of peculiar interest as it applies only to persons subjected to the changes occurring in rapid flight. Apparently it is not the velocity *per se* which affects the man but rapid changes in speed, either through an increase or decrease, which exerts its influence. Some of these effects are described as follows: At two gravitational units, designated as "g," (each unit being the force which will pull a body toward the earth with an acceleration of 32 feet per minute) there is an increase in the sensation of pressing on the surface upon which the aviator is seated; at 4 g, the legs and arms become heavy and can only be moved with effort, at 5 g the extremities cannot be moved at all, the blood is felt to leave the face, respiration becomes difficult, there may be loss of vision, and later, loss of consciousness. The objective symptoms are attributable to the fall in blood pressure which results from an accumulation of blood in the abdominal vessels. This causes a decrease in the return of blood to the heart, with an associated fall in the cardiac output. "Black out" occurs before loss of consciousness because when the blood pressure drops sufficiently, the intraocular pressure will cause the retinal vessels to collapse while the blood will still flow through the retinal vessels. If the blood pressure falls to the vicinity of the intraventricular pressure, then consciousness is lost.

The above brief discussion is given to provide a sample of one of the many interesting phases of the subject which are presented. There are many more, the elucidation of which should be enjoyable to many physicians or intelligent laymen who have a desire to understand some of the complexities of this phase of aviation.

Commander Gemmill writes clearly, and has the capacity to simplify intricate problems, a certain sign that he has an excellent grasp of his

subject. I know of no other book which presents this information in such concise but at the same time comprehensive and readable fashion.

C. C. STURGIS

#### THE PERMEABILITY OF NATURAL MEMBRANES.

By Hugh Davson, D. Sc., Associate Professor of Physiology at Dalhousie University, Canada; formerly Demonstrator in Biophysics and Beit Memorial Fellow, University College, London, and James Frederic Danielli, D.Sc., A. I. C., Beit Memorial Research Fellow and Fellow of St. John's College, Cambridge, England. With a Foreword by E. Newton Harvey, Professor of Physiology in Princeton University, U. S. A. Cloth. Price, \$4.75. Pp. 361, with 73 illustrations. Cambridge: At the University Press. New York: The Macmillan Company, 1943.

This most interesting work endeavors to give a survey of the field of cellular permeability from the modern, quantitative viewpoint. The experimental material has been selected with the view of disclosing underlying mechanisms. The authors point out, however, that many of the experiments presented are not yet amenable to clear interpretation on the basis of any of the current hypotheses.

The presentation is designed, of course, for the student of general physiology; but the chapters on hemolysis, on membrane permeability in relation to secretion, and on the kidney may be of interest to the clinician.

Recognized as primary to the whole subject is the nature of the so-called plasma membrane which separates the cell from its environment. A critical examination of this involved matter goes far toward explaining the difficulties and complexities encountered in experimentation and interpretation. The authors employ the notion of a very thin plasma membrane in their theoretical treatment. This is perhaps necessary as a first approximation to a general theory; but one wonders if this viewpoint is sufficient for all of the permeability characteristics usually encountered.

This work, although not an exhaustive treatise, represents a long forward step in an important and difficult field of physiology. The authors are to be commended for their labors of selection and exposition. Perhaps the book will accomplish their hope, that it will assist in defining what can, and what cannot, be done by the cell membrane, by 'surface action' and by 'changes of permeability'.

BARNETT COHEN

## DEPARTMENT OF TECHNIQUE

*Department Editor:* ROBERT B. TAFT, M.D., B.S., M.A., 103 Rutledge Ave.  
Charleston, S. C.

## ANALYSIS OF THE TARGET CONDITION OF ROTATING ANODE TUBES WITH A SPINNING TOP

By JOHN E. WHITELEATHER, M.D.  
MEMPHIS, TENNESSEE

THE first indication of pitting, peeling and roughening of the surface of the target of a rotating anode tube is a decrease in the output. This occurs so gradually that it is usually not noticed until a previously satisfactory technique no longer

made, it will be noted that this effect is not constant; occasionally several successive dots will be of normal density. Should another tube happen to be attached to the same transformer and the effect not noted on exposures with that tube, emission lim-

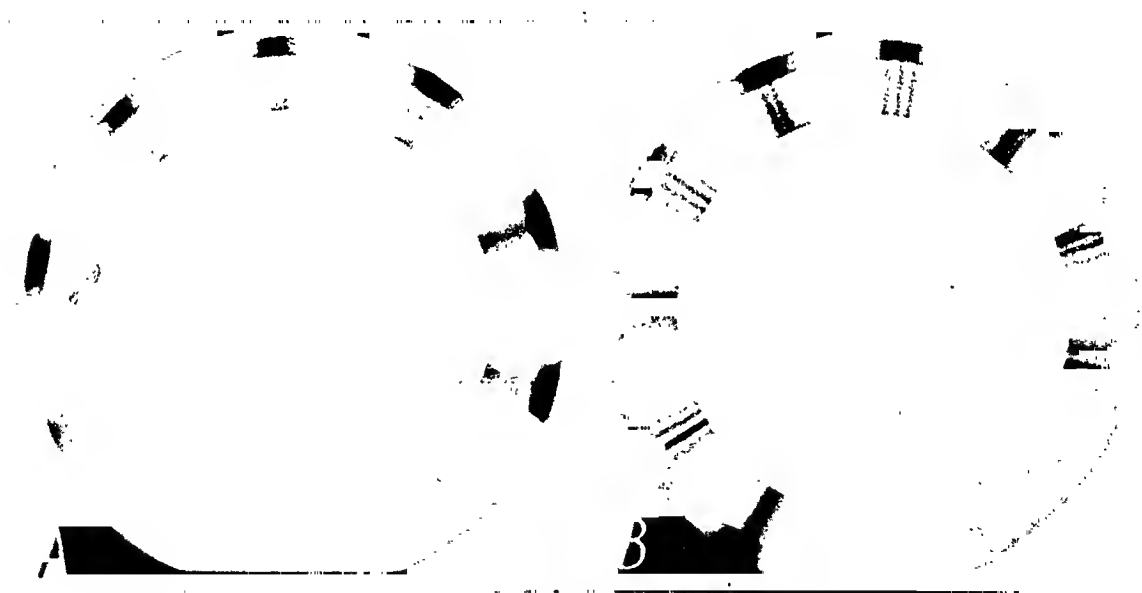


FIG. 1. *A*, normal pattern, new tube, full wave. *B*, striped, irregular pattern, old tube.

er produces acceptable roentgenograms. When a noticeable increase in exposure is required, one may begin to hunt for equipment failures.

If a film is exposed with an ordinary spinning disk top, a spinning top is used to check short exposures, a positive alternation may be noted in the density of the dots. Quite frequently, even if other factors are light or absent, a number of such films are

ited valve tubes and other mechanical defects may be eliminated.

Taft and Henny<sup>1</sup> have described the characteristic pattern produced by target irregularities on the ionization oscillogram. The instrument they devised is not available to every roentgenologist. Roentgenograms made with a large slotted disk,

<sup>1</sup> Taft, R. B., and Henny, G. "Ionization Oscillogram," *Ann. N. Y. Acad. Sci.*, 1941, 46: 25-27.

spinning at high speed, will give a stroboscope-like pattern which is just as characteristic.

Irregularities of the target absorb or scatter the radiation as they pass through the focal spot, resulting in stripes of vari-



FIG. 2. Anode of tube, spinning top pattern  
Figure 1B.

able width and density on each exposed spot. Also, since the target of most tubes rotates at from 3,000 to 3,400 r.p.m., the worst irregularities may obtrude almost in synchronism resulting in alternate light exposures on successive impulses.

A rather large disk with sufficient diameter to spread the exposure of each impulse over a wide area of film will give the best results. Instead of a round hole near the periphery, a thin slot (about the width of the ordinary hack saw blade) cut radially near the edge is required. Since the top must be spun at high speed, it should not be too heavy; 1/16 or 3/32 inch steel is quite satisfactory. It could be made of brass or wood with a layer of light lead glued to the top. The spinning knob should be knurled and the disk well balanced so

there will be no tendency for it to "walk" on the smooth cassettes.

Dimensions may be varied to suit the material at hand but the following have been found satisfactory. The disk should have a minimum diameter of 12 to 14 cm. The slot can be cut 2 to 3 mm. wide with a hack saw and 15 to 25 mm. deep. The outer end may be widened to 5 to 6 mm. with a thin file and the outer margin plugged with a piece of lead. Widening the outer end of the slot is not necessary but permits two different densities for each impulse. The

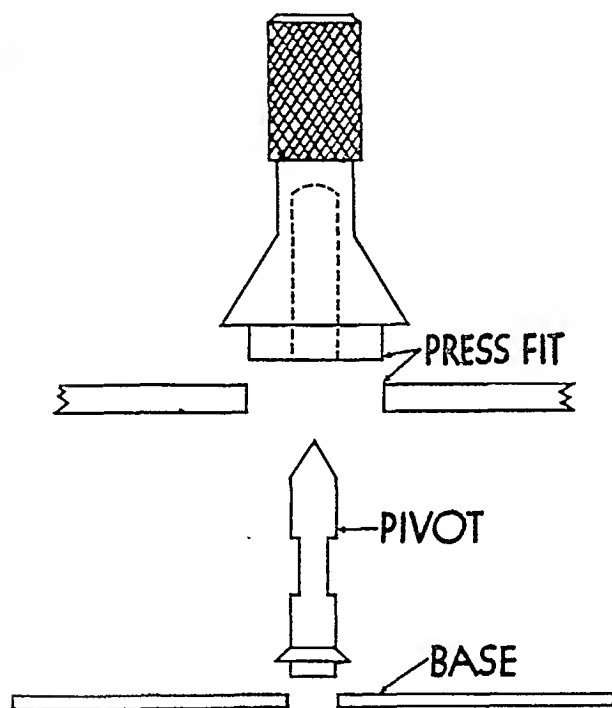


FIG. 3. Diagram of construction of spinning knob, pivot and base of top.

pivot should be so constructed as to reduce friction. If the knurled spinning knob is bored from the bottom, and press fitted into the disk, it can be spun upon a pointed pin projecting into the hole. This pin should be slotted or grooved upon a lathe so as to leave two narrow bearing surfaces as shown in Figure 3. Exposures can be made at 50 to 60 kv., 50 to 200 ma., 30 to 35 inch distance on par-speed screens.

It is important to check rotating anode tubes at intervals for surface irregularities since the targets are not visible. Roughen-



ing often occurs gradually and the decrease in detail or alteration in technique may not be noticed. The tube shown in Figure 2 first exhibited spinning top changes six months before it became so bad as to require replacement. There had been over 60,000 exposures of all types but it still operated satisfactorily in all other respects.

After installation of a new tube, it was possible to reduce kilovoltage 10 to 15 kv. and improvement in detail was quite evident.

This method is well known to tube manufacturers but does not seem to be a subject of general knowledge.

Baptist Memorial Hospital  
Memphis, Tenn.



## DEVICE FOR ACCURATE CENTERING OF THE STOMACH IN ROENTGENOGRAPHY\*

By BERNARD WITTENBERG  
BROOKLYN, NEW YORK

THROUGH years of experience as a roentgen technician in hospitals and private offices, I have found that accurate localization of the stomach when taking roentgenograms of patients is a practical necessity.

For better positioning as well as for economy in time and film, I have found that a simple yet accurate mask for positioning the patient during roentgenoscopy serves the purpose. The mask has been particularly valuable for centering the stomach in the Trendelenburg position and, in general this simple device has facilitated the making of gastric studies, has saved innumerable repeat examinations and has been a saving in time and cost as well as giving consistently good results.

The mask is a rectangular frame made of three ply-wood with the inner dimensions 12 by 14 inches and the outer 16 by 18

surface, at the four corners, are rubber headed nails about  $\frac{1}{4}$  inch in diameter, to keep the mask from sliding.

White crayon or suitable markings are used to mark off the inner diameters and the center of the mask to show where to center the film in the Potter-Bucky diaphragm to the mask. Two parallel lines 12 inches apart are marked on the table top horizontally and the center line of the table is then ready for use (Fig. 1).

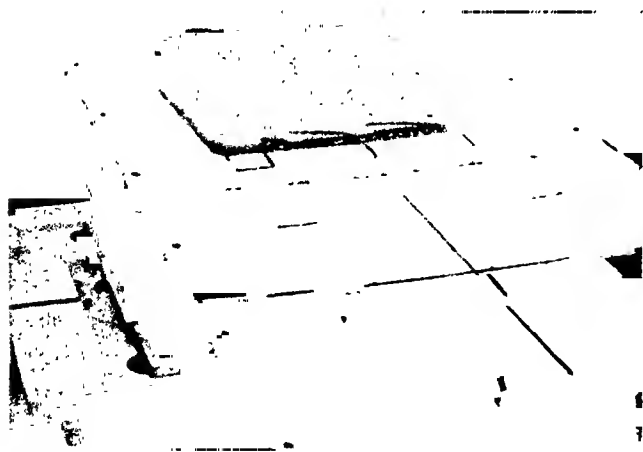


FIG. 1. The mask placed lengthwise on table with all markings shown.

inches. It is a single piece of wood. The middle ply of the board is cut or scraped out  $\frac{1}{2}$  inch wide at the inner margins, and  $\frac{1}{2}$  inch strip of lead foil is glued in its place all the way around the board. Plastic wood is used to fill in the space left. On the under



FIG. 2. An 11 by 14 inch roentgenogram taken lengthwise in the Trendelenburg position.

Previously we used a tunnel for positioning but now find that with this simple mask there is less distortion, because distance between the stomach and table has been reduced to a minimum.

*Trendelenburg Position.* The mask is

\* From the Department of Roentgenology of the Jewish Sanitarium and Hospital for Chronic Diseases, Brooklyn, N. Y.

placed in the long axis centering the mask to table with the inner diameters 1 inch above and 1 inch below the two horizontal marks on the table.



FIG. 3. A 10 by 12 inch roentgenogram taken crosswise in the prone position.

The patient is placed in the supine position with the crest of the ilium at the lower end of the mask. The table is tilted cephalad to the angle desired. The patient is then roentgenoscoped and placed so that the stomach is centered on the mask. An 11 by 14 inch film is placed in the Potter-Bucky tray lengthwise and centered to the mask. The film is exposed with the routine technical exposure. Figure 2 shows a roentgenogram taken in this position.

*Supine Position.* The same procedure is followed as in the above position, only the tilting of the table is omitted. This position is used only in rare instances such as for a patient whose spinal column is one solid bridge of bone with a marked kyphosis.

*Prone Position.* The mask is placed crosswise with the marks centered at the horizontal lines and center line of the table. The patient is placed in the prone position, the abdomen on the mask. During roentgenoscopy, the stomach is centered to the mask in either posteroanterior or oblique position. If the patient has the asthenic or sthenic type of stomach a 10 by 12 inch film is used crosswise (Fig. 3); if slightly hypersthenic a 10 by 12 inch film is used lengthwise, although the mask is still



FIG. 4. A 10 by 12 inch roentgenogram taken lengthwise with the mask on table crosswise.

placed crosswise (Fig. 4). If the patient is markedly hypersthenic the mask is placed lengthwise on the table and an 11 by 14 inch film is used lengthwise.



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# ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

## ROENTGEN AND RADIUM THERAPY

Watson, T. A. Subcutaneous x-ray therapy. *Brit. J. Radiol.*, April, 1943, 16, 113-114.

Few carcinomatous glands are cured by roentgen therapy because they require a larger dose for cure than the skin over them can tolerate. The muscle and connective tissues around them are, however, relatively insensitive to irradiation. It is suggested therefore that a skin incision be made over the gland and the skin dissected back so that the irradiation is given only through the remaining overlying tissues. This makes the gland accessible and makes it possible to give a large enough dose to cure the gland without injuring the skin. The quality and focus-skin distance of the rays depend on the size of the gland. Probably a medium voltage treatment with a distance of about 15 cm. would prove most useful in the majority of cases.

This method has been used in about 50 cases in the past year. Because of the highly experimental nature of the method cases were selected in which only palliative treatment could be used. The disadvantages of the one large dose used in this method as compared with the fractional method may be outweighed by the high tolerance of connective tissue.—*Audrey G. Morgan.*

Koernig, Edward C., and Culver, Gordon J. The value of roentgen therapy in carcinomatous metastases to bone. *Radiology*, July, 1943, 11, 33-41.

Many physicians and surgeons when they discover bone metastases of carcinoma simply give the patient up and keep him under morphine until death. It is pointed out that roentgen treatment is effective in alleviating pain in such cases, improving the general condition and prolonging life. Even a few months' restoration to normal life makes the treatment decidedly worth while. It is wise as a matter of routine to make roentgenograms of the pelvis and spine in cases of malignant lesions which commonly metastasize to bone. The commonest of these is carcinoma of the breast. Generally

alleviation of pain can be brought about in ten days and sometimes even in five days. There is no correlation between the patient's symptomatology and general condition and the roentgen findings. Therefore treatment must be based on the patient's condition rather than on the roentgen findings. The amount, duration and site of treatment vary with each individual case. If a patient with previous cancer shows roentgen lesions in the bones, treatment should be begun even if there are no symptoms. If he shows symptoms that cannot be otherwise explained, treatment should be begun even though the roentgenogram shows no bone changes. In short, the earlier treatment is begun, the more effective it promises to be.—*Audrey G. Morgan.*

Gershon-Cohen, J. Giant-cell tumors: radiation therapy and late results. *Radiology*, Sept., 1943, 11, 261-267.

This report is based on a review of 29 cases. The late results with radiation treatment alone are good; among 14 cases treated in this way 2 underwent malignant degeneration, 1 six years and the other nine years after treatment; some suffered intercurrent fractures. In 14 cases treated by surgery and irradiation, the late results were also good, but there was a greater incidence of intercurrent fractures, repeated operations and infections, and the periods of illness were longer. Fixation or splinting is of great value, no matter whether surgery or irradiation is used. Intercurrent fractures can generally be avoided by relieving the bone of weight bearing. Changes in the technique of irradiation did not seem to make much difference in the rate of healing.

Many patients do not respond to irradiation well at first and recalcification may be delayed for many months. Giant cell tumors generally originate in or near the cortex and gradually extend into the marrow cavity as growth progresses. They seldom if ever extend across the line of the epiphysis before fusion. The closeness of giant cell tumors to the growing epiphysis before fusion is a complicating factor in their roentgen treatment. If the total dose is 60

more than 2,000 to 3,000 r—and this total may not be necessary—the growth of the epiphysis is not materially affected. There are more apt to be secondary atrophic changes of overlying soft tissues which affect joint function.

The best treatment of these tumors would seem to be roentgen irradiation alone given in close cooperation with the surgeon. The percentage of cures with irradiation alone is possibly as high as 85 per cent or more.—*Audrey G. Morgan.*

DRIVER, J. R., and MACVICAR, DONALD N.  
Cutaneous melanomas; clinical study of sixty cases. *J. Am. M. Ass.*, Feb. 6, 1943, 121, 413-420.

The great majority of cutaneous melanomas arise from pigmented junction type nevi in the skin. In color these nevi vary from slate blue to bluish black or various shades of brown to jet black with lighter and darker shades often present in the same lesion. These precursor lesions are usually smooth and flat but occasionally may be raised with a verrucous or wrinkled surface and are nearly always soft. The number which become malignant is extremely small. The authors believe that the soft flat slate blue, bluish black and black moles are the most dangerous. Also those developing later in life are more apt to become malignant and show a tendency to metastasize earlier.

Melanomas include tumors called malignant melanoma, melanocarcinoma, melanoepithelioma, nevocarcinoma, melanoblastoma and melanosarcoma. There appears to be no particular difference in the degree of malignancy of the various types. However, it is well known that the well differentiated tumors are the most dangerous because of the tendency to early metastasis. The first change in the transition from a benign pigmented melanotic nevus to a melanoma is most likely to be an increase in the size of the lesion by peripheral extension and by an increase in pigmentation. A flat lesion may become raised and indurated, and this is followed by bleeding, ulceration and the development of fungoid tumor masses. Radiating projections of pigment may be seen in the surrounding normal skin and indicate local dissemination. An increase in pigmentation is an early warning sign.

Metastasis occurs comparatively early. Dissemination may occur by way of the superficial lymphatics of the skin, in which case nodules or

pigmented areas develop in the neighboring skin. If spread is by the deep lymphatics, the regional lymph nodes become enlarged, discrete and hard. Frequently dissemination may be through the blood stream.

Concerning the treatment of pigmented moles, opinions vary from the removal of no moles to the removal of all of them. There is general agreement among authors that if pigmented nevi are to be treated at all they should be thoroughly destroyed or excised, with a liberal margin of healthy tissue. The authors remove pigmented junction type nevi for prophylactic and diagnostic purposes, if located on areas subjected to chronic irritation. This has been done by scalpel excision, with a margin of approximately one-half inch of healthy tissue, including the subcutaneous tissues. In some instances thorough destruction by the electrocautery or electrodesiccation has been employed. They believe that these lesions should not be treated by irradiation or by any method requiring repeated treatments. In the treatment of melanoma, the method is not so important as long as the melanoma is completely surgically excised or thoroughly destroyed. Wide scalpel excision was performed in the majority of instances, while electrodesiccation or the electrocautery was employed chiefly in early clinically suspicious lesions that were small in size. Follow-up irradiation to the operative field with filtered roentgen rays, with Coutard technique in doses of 5,000 to 8,000 roentgens, was employed in 6 cases in this group. In summarizing, it is stated that of a series of 60 patients with melanomas, a group of 25 patients seen in hospital surgical practice presented themselves for treatment, comparatively late, with relatively advanced malignant growths and a large percentage showing metastatic involvement. Only 2 patients are known to be alive more than five years later. The mortality rate was 92 per cent. Of the other group of 35 patients seen in dermatologic practice 17, or 48.6 per cent, survived from seven to eighteen years. As a group these patients were seen comparatively early in their disease and the great majority were free of metastatic dissemination when they were first treated. The results obtained indicate that the only hope of reducing the high mortality rate in cutaneous melanoma lies in early diagnosis and thorough destruction of the primary lesion before dissemination takes place.—*S. G. Henderson.*

COLBY, FLETCHER H., and SCHULZ, MILFORD D. A review of carcinoma of the bladder treated by supervoltage x-rays over a five-year period. *Radiology*, 1943, 41, 371-377.

During the five year period since a 1,000 kv. unit for the treatment of deep-seated malignant new-growths was installed 139 cases of cancer of the bladder have been treated at the Collis P. Huntington Memorial Hospital in Boston and the Massachusetts General Hospital. In both hospitals daily doses of 300 to 400 r (in air) were given, alternating through anterior and right and left oblique fields. The total radiation given to each field was 2,400 to 3,600 r. This course was followed by a second in three to four weeks with 1,200 to 1,600 r to each field. Occasionally a third smaller course was given after another three weeks.

The authors believe that operable bladder tumors are still best treated by as radical operation as possible followed by the implantation of radium, or in some cases by total cystectomy. The best results from external irradiation were in non-papillary infiltrating tumors of a high grade of malignancy while large papillary tumors of the lowest grade of malignancy showed the least response. That is, the more rapidly growing and undifferentiated the cells, the better the effect of irradiation.

In about half of the cases there was relief of pain and discomfort. Excessive bleeding was usually controlled and some cases were so much improved in this respect that they became operable. The skin tolerated the dosage given very well; there was only a slight skin reaction. Proctitis with diarrhea and cystitis developed in many cases during the last week of treatment but could be controlled. Tables are given showing end-results of treatment and life expectancy. The authors believe high voltage treatment has brought about some improvement as their results show 40 in 100 chances of the patient's life four years after onset of the disease while the statistics of Nathanson show 10 in 100 to within three years of the institution of high voltage therapy. The authors show only 20 chances in 100.

The table shows that 40 patients survived for only six months, 30 for six months to a year, 12 for a year to a year and a half, 18 for a year and a half to two years, 6 for two to three years, 4 for three to four years, 2 for four to five years and 2 for more than five years. These last 2 are

still alive. The best results were seen in a group in which the tumors were so much reduced by external irradiation that radon seeds could be implanted. Among a group of 13 such cases, 9 are still alive after more than a year, 4 for over two years and 2 for over four years.—*Audrey G. Morgan.*

NEARY, G. J. The physical aspects of intracavitary radium treatment of carcinoma of the cervix uteri. Part I. *Brit. J. Radiol.*, Aug., 1943, 16, 225-233.

Intracavitary radium has been found to be a better treatment for cancer of the cervix than external roentgen irradiation. In studying the question of the efficiency of radium alone, it is necessary to know the anatomy of the lymphatic drainage of the pelvis, which is described in relation to the application of radium. An analysis is given of the distribution of dosage from the uterine applicator and it is found to be poor. The distribution of dose from the vaginal applicator is found to be considerably better than that from the uterine applicator. The antero-posterior position of the radium sources is much more important than the lateral position. The distribution of dose from uterine and vaginal applicators combined is analyzed and the optimum arrangement described. The position of the vaginal applicators in most techniques is relatively unimportant. Improvement can be brought about only by modifying the uterine applicator or increasing the amount of radium in the vaginal applicator.

The effect of the radium on the rectum is considered and it is found that a single central source of radium is better than two sources in the vagina. The optimum arrangement is described; it is found to consist normally of a single vaginal applicator without a uterine applicator.

Possible clinical improvements are considered, such as the use of a platinum absorber to shield the rectum, and a modification of the uterine applicator by concentrating the radium at the fundus. The improvement brought about in this way involves a considerable increase in the total number of milligram hours but there is no danger if suitably designed applicators are used. The integral dose still remains much smaller than the roentgen-ray dose.

The tables and calculations on which these conclusions are based are given.—*Audrey G. Morgan.*



NEARY, G. J. The physical aspects of intracavitary radium treatment of carcinoma of the cervix uteri. Part II. *Brit. J. Radiol.*, Sept., 1943, 16, 263-269.

The Donaldson technique is discussed and the method of measuring the dosage rate described. The technique consists normally of three radium applications of twenty-four hours each, the first interval being one week and the second two weeks. In both vaginal applicators the filtration is 0.5 mm. platinum, plus 2 mm. of silver, the two being equivalent to 1 mm. platinum. The vaginal applicator is the butterfly pessary, consisting of two boxes on two arms attached to a central stem. The distance between the boxes may be changed by changing the angle of inclination of the arms. During treatment the boxes lie in the lateral fornices. The uterine tube is about 6 cm. in length and 6 mm. in diameter and is slightly bent at the middle to correspond to a moderate ante flexion of the uterus of  $15^\circ$ . A diagram of the arrangement of the applicators is given and tables showing the dosage rates at various points in the pelvis. The dose in the parametrium is 6,750 r, while that in the first principal lymph node near the lateral wall of the pelvis is 1,900 r. The measured values agree well with the calculated values. The dosage rate at the anterior wall of the rectum is about 3,000 r. Because of the rapid variations with change in position it is not possible to give a typical bladder dose. It may perhaps be tentatively estimated that the dose at the internal orifice of the urethra is about 3,600 r in seventy-two hours total irradiation. The dose at the internal orifice of the obturator canal is not more than 1,400 r, with a strongly anteverted uterus. Dosage rates in the immediate vicinity of the vaginal boxes were examined and the figures are given. There is no evidence that the vault of the vagina receives higher doses with the boxes than with corks. Very little of the mucosa receives more than 14,000 r. It is evident that a box serves as a point source at distances beyond 2 cm.—*Audrey G. Morgan.*

HARVEY, ROBERT A., and RITCHIE, ROBERT N. Carcinoma of the cervix complicated by complete procidentia: radiation therapy. *Radiology*, July, 1943, 41, 48-51.

The author reviews 78 cases of procidentia with carcinoma of the cervix reported in the literature and describes a case of his own in a

white woman eighty-one years of age. He treated his case with 3,600 r, measured in air, and given over a period of thirteen days. The tumor shrank to half its original size and the prolapsed uterus receded into the vagina. The patient was then given a total dose of 3,500 milligram-hours radium. A year after treatment the patient reported that she had no pelvic symptoms at all and was in good health.

It is better in these cases to give roentgen treatment before radium for the initial use of radium would result in unequal distribution of the rays in the tumor and adjacent tissues. These tumors are still quite generally treated by surgery. This is the second case recorded in which irradiation alone was used. In view of the results the author advises deep roentgen therapy followed by radium.—*Audrey G. Morgan.*

RICHES, E. W., WILLIAMS, I. G., and HADDOW, ALEXANDER. The treatment of carcinoma of the prostate. Symposium. *Brit. J. Radiol.*, July, 1943, 16, 187-198.

Riches discussed symptoms, treatment and results in 70 cases of carcinoma of the prostate. About 20 per cent of patients with prostatic obstruction have malignant disease. There are two types of carcinoma of the prostate—primary carcinoma developing in a previously normal gland and carcinoma developing secondarily in a prostate already hypertrophied or affected by adenoma. The symptoms in the two types are the same and are those due to obstruction. Additional symptoms are caused by metastases which are more frequent in the lymphatic glands than in the bones or viscera. The internal iliac glands are most frequently affected—in 73 per cent of the cases in Muir's statistics and this limits the possibilities of surgical treatment alone. The prognosis depends on the degree of advancement of the disease when first seen and on its clinical and pathological type. The author has seen a case of actual cure of carcinoma of the prostate but one of his patients survived ten years and died of recurrence. Length of survival is increased by the association of radiotherapy with surgery, and pain is decreased. Treatment of a diagnosed case by endoscopic resection and roentgen irradiation gives an average survival period of nearly two years, while treatment of an unsuspected case by prostatectomy and roentgen irradiation gives an average survival of more than three years.

Williams discussed the radiotherapy of carcinoma of the prostate, emphasizing the importance of such localization and beam direction as to permit of the use of smaller fields and an increase of the tumor dose to high levels without undue exposure of normal tissues. He thinks the future progress of radiotherapy of prostatic carcinoma depends on the working out of greater accuracy of beam direction and possibly on the use of higher voltages. He has had no experience with interstitial radium therapy but thinks it may be useful if the greatest possible homogeneity of dosage is attained within the tumor and the paths of spread dealt with by external irradiation.

Haddow discussed the increase of acid phosphatase levels in the blood in carcinoma of the prostate, particularly in metastases. This high level decreases after castration and there are both local and general signs of improvement in the disease. There is a study of the clinical and pathological effects following the administration of estrogens in this disease and attention is called to the practical results which may follow the apparently theoretical study of chemical and biochemical problems, such as the acid and alkaline phosphatase content of the serum in different conditions. — *Audrey G. Morgan.*

MAXFIELD, J. R., JR., MELLWAIN, A. J., and ROBERTSON, J. E. Treatment of radiation sickness with vitamin B<sub>6</sub> (pyridoxine hydrochloride). *Radiology*, Oct., 1943, 41, 383-388.

It has been difficult to determine the cause of irradiation sickness but it now appears that it is much more apt to occur in patients suffering from malnutrition, debilitation and avitaminosis. The radiologist himself should see to the nutritional balance of his patient and not leave it to the attending physician. Vitamin B<sub>6</sub> and the vitamin B complex were first tried in the treatment of this sickness but they were not always effective. The authors then began the use of vitamin B<sub>6</sub> (pyridoxine hydrochloride), giving 25 mg. intravenously per day. They now recommend that this dosage be repeated at intervals of twenty-four to seventy-two hours as needed during the rest of the radiation treatment. They have had excellent results in 10 cases. The drug is safe, simple to give and has no contraindications. A table is given showing the treatment and results in 22 cases. There was failure in only 1 case, in which the drug was given intramuscularly. When the patient was

subsequently given further irradiation the drug was given intravenously and the results were good. Other methods of treatment, such as the use of liver extract, a high vitamin intake, the use of sedatives, etc., are to be encouraged in connection with this treatment if they are needed. — *Audrey G. Morgan.*

#### MISCELLANEOUS

POHLE, ERNST A., McANESY, JOHN B., and LOVELL, B. K. Radiation therapy in carcinoma of the rectum and sigmoid. An experimental study of the "danger" dose of roentgen rays for the intestinal mucosa in dogs and an analysis of 195 cases treated in the State of Wisconsin General Hospital during 1928-38. *Radiology*, Sept., 1943, 41, 225-232.

It cannot be said that irradiation alone will cure any considerable percentage of carcinomas of the rectum and sigmoid while radical operation in the early stages of the disease gives a five year survival rate of about 50 per cent. No data could be found for the tolerance dose of the rectum or sigmoid so the authors performed experiments on dogs to determine the "danger" dose for intestinal mucosa. Nine adult dogs with an average weight of 10 kg. were irradiated with doses of 600, 900, and 1,200 r (in air) per field. The treatment was given all at once except in one case in which the fractional method was used. The dogs given a dose of 1,200 r died in 14, 48 and 52 days after the treatment. Those given 600 r had little or no reaction in the mucosa though they suffered roentgen sickness for some three or four weeks. Those given a dose of 900 r showed ulceration and perforation of the rectum.

There is also a discussion of 195 cases of cancer of the rectum and sigmoid treated at the Wisconsin General Hospital. The percentage of five year survivals was very low, but many of the patients came with quite advanced lesions and a good many did not return to complete the course of treatment prescribed. It is impossible from this series to determine with any degree of accuracy the value of postoperative irradiation. But there is no doubt that preoperative irradiation often renders an inoperable tumor operable by relieving fixation. It is also true that considerable palliation can be brought about by roentgen treatment or roentgen rays and radium combined, and metastases, especially in bones, are distinctly benefited by roentgen therapy. — *Audrey G. Morgan.*

RAAB, W., and SOULE, A. B., JR. Effect of roentgen irradiation on the hormone content and secretion of the adrenal medulla. *Radiology*, July, 1943, *41*, 56-60.

The adrenal region in white rats was irradiated with roentgen doses of 100 r and 1,000 r. Tables are given showing the details of the results. There was no significant change in the hormone content of the medulla of the glands within sixty-eight hours. The early increase in weight of the glands within sixty-eight hours after a dose of 1,000 r was due to the initial hyperemia. But after sixty to sixty-eight days there was decreased secretory activity after a dose of 100 r and a similar decrease, combined with slightly decreased hormone production, after irradiation with 1,000 r.

Other investigators have found a specific depression of irritability of the sympathetic nervous system, of which the adrenal medulla is a part, on roentgen irradiation. This is consistent with the findings of Raab in previous work, which showed an abnormal discharge of adrenal hormone into the blood within a few minutes after exercise in patients with angina pectoris. On roentgen irradiation of the adrenal region this abnormal discharge stopped and essentially normal conditions were restored. Subjective symptoms were also overcome and the electrocardiogram became normal. Evidently the irradiation depressed the abnormal secretory activity of the glands.

No significant structural changes were found in the adrenal glands of 3 patients who had been treated from a few weeks to thirteen months before death.—*Audrey G. Morgan.*

TCHAPEROFF, IVAN C. C. Preliminary notes on the effect of roentgen rays on sulfonamides in vitro. *Radiology*, July, 1943, *41*, 61-63.

The author discusses work done on the sulfonamides at the Vancouver General Hospital, Vancouver, B. C. It has been found that while both roentgen irradiation and sulfonamides are beneficial in infection, they are useless or even harmful if used together. The author's experiments were made with the object of determining whether under the action of irradiation the products of break-down of the irradiated drugs might have an unfavorable action, either stimulating the growth of bacteria or injuring the tissues.

He used stock solutions of pure sulfanilamide and sulfathiazole and irradiated them with un-

filtered radiation. A table is given showing the details of the results. The two drugs are equally changed by irradiation, the change apparently being an alteration of the  $\text{NH}_2$  group. As the sulfonamides can be broken down by irradiation in vitro it is probable that they can be broken down by much smaller doses in the body and it is probable that the break-down of even a small fraction of sulfonamide neutralizes the beneficial action of a much larger quantity of the unirradiated drug. The exact nature of the compounds produced by the irradiation of the sulfonamides is not known. These drugs have a bacteriostatic action and it now seems probable that irradiation also has such an action; it is a chemical action which directly inhibits the growth factor of bacteria.—*Audrey G. Morgan.*

LASNITZKI, ILSE. The response of cells *in vitro* to variations in x-ray dosage. *Brit. J. Radiol.*, May, 1943, *16*, 137-141.

Irradiation of cultures of the choroid and sclerotic of chick embryos with doses of 100 and 1,000 r has been described in previous articles. This article deals with the irradiation of the same kind of cultures with doses of 2,500, 5,000 and 10,000 r. Tables giving the details of the results and plates showing the appearance of the cells are given. These larger doses brought about breaking down of the cells soon after irradiation. The greatest number of degenerate cells were seen with all these dosages three hours after irradiation. Cell death with the lower doses seemed to be associated with the entry of the cells into mitosis. It has been shown that if the cells are prevented from entering upon mitosis after irradiation, for instance by cooling, degeneration does not take place. But with the higher doses used in this series of experiments the cells break down in the resting condition.—*Audrey G. Morgan.*

DALE, WALTER M. The effect of x rays on aqueous solutions of biologically active compounds. *Brit. J. Radiol.*, June, 1943, *16*, 171-172.

This article discusses a series of investigations on the effect of irradiation on enzymes. It was found that dilute solutions of enzymes were radio-sensitive and could be almost completely destroyed by a small dose, while concentrated solutions were radioresistant and apparently unaffected by irradiation. This is called the dilution phenomenon. It was also found that enzymes were protected when irradiated with

their substrate. This is called the protection phenomenon. The dilution phenomenon is explained by the fact that the irradiation acts primarily on the water and forms intermediate products which in turn act on the substances in solution. Another reason why enzymes have been considered radioresistant is that they were often subjected to irradiation in an impure state without the protective action of other substances being taken into account.

It is hoped that a further study of the indirect action of irradiation on enzymes, and of the dilution and protection phenomena will bring about a better understanding of the effects of radiation in the more complex field of the living body. *Audrey G. Morgan.*

GRAY, L. H., READ, JOHN, and POYNTER, M. The effect of ionizing radiations on the broad bean root. Part v. The lethal action of x radiation. *Brit. J. Radiol.*, 1943, 16, 125-128.

The authors have previously studied the lethal effect of gamma rays, neutrons and alpha particles on the broad bean root. This paper reports the results of exposure of the bean roots to roentgen rays having a mean wave length of about  $0.16 \text{ \AA}$  under comparable conditions which are described, and tables and graphs showing the results are given.

If all other factors are kept equal there seems to be a general tendency for the biological effectiveness of roentgen radiation to be greater than that of gamma radiation, a difference which is almost certainly correlated with the difference in the linear density of ionization along the tracks of the ionizing particles generated by the two kinds of radiation. The difference in ion density between roentgen and gamma radiation is, however, so small that such differences in efficiency as exist would be hard to demonstrate experimentally. *Audrey G. Morgan.*

PATON, M. M. Limitations of physics in radium therapy. *Radiology*, Oct., 1943, 44, 330-336.

The author discusses the Paterson-Parker system of charts on which dosage and the distribution of radium radiation around various applicators is based. He says that the system falls short of the mathematical ideal by permitted tolerances. It is questionable whether these

tolerances are acceptable in view of other possible errors in radium therapy or whether a more accurate system should be sought. Perfect implantation is limited by the number of sources that can be introduced without excessive trauma, the skill with which they are inserted in the desired position and the reconstruction of the implant for accurate dosage calculation. Even a perfect distribution would be modified by absorption and scatter in tissue and it would be unwise to elaborate a system to closer limits than the changes brought about by these causes. The original system took cognizance of oblique filtration only in special treatments with long single sources. In all cases the dosage rate in some parts of the irradiated area will be reduced by oblique filtration. Various shaped applicators are illustrated and the dosage distribution worked out. Calculations with radium tubes are based on the assumption that the tubes are properly filled. Bad packing may lead to serious errors. Curved surfaces are not amenable to good mathematical treatment and the error in determination of the area treated with such curved surfaces may be as large as 10 per cent. It is not easy to mount radium tubes on wax or similar applicators so that they will be within 0.5 mm. of the correct distance. It is always advisable to supplement dosage calculation by direct ionization measurement. Reading at selected points can correct the principal errors in dosage rates. The author has found closer agreement between measured and calculated doses than would be expected from the many possibilities of error.

In the discussion Major Friedman called attention to the difficulties in the use of the intra-uterine tandem in the treatment of carcinoma of the cervix. It is made by placing several radium capsules inside a rubber tube; a cotton plug is then inserted to fix the radium in position and the rubber tube is tied with a thread. When this applicator is inserted into the uterine canal the lowest radium tube will often lie just above the cervix, which is occupied by the cotton plug, the thread and the distal empty part of the rubber tube. Moreover, the oblique filtration of the lowest radium capsule is often such that the dose to the cervix is reduced.

Dr. Parker replied that interstitial treatments are up to the clinician. Treatment within the cervix is a subject that no physicist likes to handle. *Audrey G. Morgan.*

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# THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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## THE ROENTGEN EXAMINATION OF THE URINARY TRACT

WITH SPECIAL REFERENCE TO METHODS OF EXAMINATION AND  
FINDINGS IN INDIVIDUALS WITH TESTICULAR TUMORS\*

By LIEUTENANT COLONEL JOSEPH C. BELL, MAJOR GILBERT W. HEUBLEIN,  
and MAJOR HOWARD J. HAMMER  
*Medical Corps, Army of the United States*

UROLOGICAL opinion concerning the importance and value of the various methods of roentgen investigation in urinary tract disease is of importance to all roentgenologists. Randall<sup>8</sup> in the *Journal of Urology* stresses the importance of intravenous urography in the demonstration of otherwise occult metastases from testicular tumors. He also emphasizes the importance of this examination in determining the prognosis in such cases.

One of us (H.J.H.) a urologist† is quoted as follows:

Of utmost importance both to the urologist and the patient is a thorough and accurate roentgenological examination by means of which the urologist is aided in arriving at an accurate diagnosis, after which the indicated treatment may promptly be initiated. Close collaboration between the urologist and radiologist will benefit all concerned. As Pendergrass has pointed out, individual ability to detect minute morphological changes in roentgenograms is subject to error. Skilled interpretation

is the result of wide experience gained by those examiners who weigh clinical and laboratory data and follow carefully the progress of their patients.

The technical aspects of the roentgen examination as well as accurate interpretation of findings are of major importance. The urologist who has the time, training and experience essential in this phase of urologic diagnosis, is the rare exception.

While the relative merits of excretory and retrograde urography have been subjected to endless series of critical appraisals in medical literature, it is the common belief of most urologists that the two methods are complementary.

The value and accuracy of the roentgen examination in the diagnosis of the many diseases and anomalies of the urinary tract are now generally recognized by all members of the medical profession.

This presentation will be limited chiefly to a discussion of some of the technical aspects of the roentgen examination of the

\* From the Sections of Radiology and Urology of the Percy Jones General and Convalescent Hospital, Battle Creek, Mich. Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24-29, 1944.

† Chief of the Section of Urology of the Percy Jones General and Convalescent Hospital.



urinary tract together with the roentgen manifestations in a few diseases that affect it. Our methods are not original, but are those, or parts of those, long employed by other workers in this field of diagnosis. We have attempted to so plan our examination that good technical results may be had and accurate diagnoses arrived at with the least essential expenditure of time and materials.

#### METHOD OF EXAMINATION

*Intravenous Urography.* The first essential is the proper selection of patients to be examined. A definite contraindication to this type of examination is advanced renal disease with marked impairment of renal function. Likewise patients in advanced stages of some other diseases are unsuitable for this form of investigation, as are those in shock, coma and in extremis.

Sensitivity to the contrast medium to be injected is also a contraindication. At the Percy Jones General and Convalescent Hospital we test for sensitivity to diodrast by the method described by Archer and Harris,<sup>1</sup> two drops of diodrast being placed in the conjunctival sac and the eye examined three to five minutes later. Normally there is no reaction to the diodrast. Evidence of sensitivity is exhibited by congestion of the conjunctival vessels. If slight or very moderate congestion is noted, however, the intravenous injection is made, but with great caution. Marked congestion is considered a contraindication, and in our hospital other means of investigation are resorted to in these individuals, who are very few in number. In approximately 600 examinations during the past fifteen months, using the above test as a guide, we have had no reactions except those of the mildest type.

In a personal communication, Archer states that he and his associates have examined 3 cases of severe asthma, in each of whom the sensitivity test to diodrast was entirely negative, but in all of whom severe and quite alarming reactions took place. Fortunately all recovered. It is Archer's opinion that a definite history of asthma

should be considered a contraindication to this type of examination even when the sensitivity test is negative.

It should be recalled that, according to Pendergrass, *et al.*,<sup>2</sup> the incidence of fatal reactions from intravenous urography in a series of 661,800 examinations was 0.0039 per cent. In other words, this represents approximately 3.9 deaths per 100,000 examinations done by roentgenologists and urologists throughout the United States and Canada.

The preparation of our patients consists of a laxative, preferably castor oil or compound licorice powder, before the evening meal prior to the morning of the examination. No food or fluid is taken after midnight and a cleansing enema is given one hour before the examination. In some cases the injection of one ampule of pitressin precedes the enema by thirty minutes, but we question the necessity and wisdom of the latter in most cases.

Prior to the injection of the particular contrast medium to be used, a preliminary roentgenogram of the entire area of the urinary tract is always made. The injection is done by one of the medical officers of the Roentgen Department who assumes responsibility of observing the patient and directing the technique employed in each individual case. This is not an examination in which any routine procedure is satisfactory. If roentgenograms are routinely made at stated intervals over a long period of time, much time and material are wasted in a large percentage of cases. If, however, few roentgenograms are secured and the examination covers only a short interval much valuable information is lost.

We inject the contrast medium slowly, usually requiring from three to four minutes. A roentgenogram of the entire urinary tract is made five minutes after the injection is completed and developed immediately. Pressure is made over the promontory of the sacrum using a compression band, the pressure being localized by placing a child's football or a basketball bladder above the pubic arch beneath the com-

pression band. In the large majority of cases the ureters are blocked at the pelvic inlet by this method. The compression is maintained for five minutes after which stereoscopic roentgenograms of the proximal half of the urinary tract area are made using 10 by 12 inch films. Preparation is

upright and the examination terminated.

If, however, function is impaired or even apparently entirely absent on one or both sides, roentgenograms of the entire tract are made, usually at fifteen minute intervals for the first hour after the injection, or until satisfactory visualization takes place.

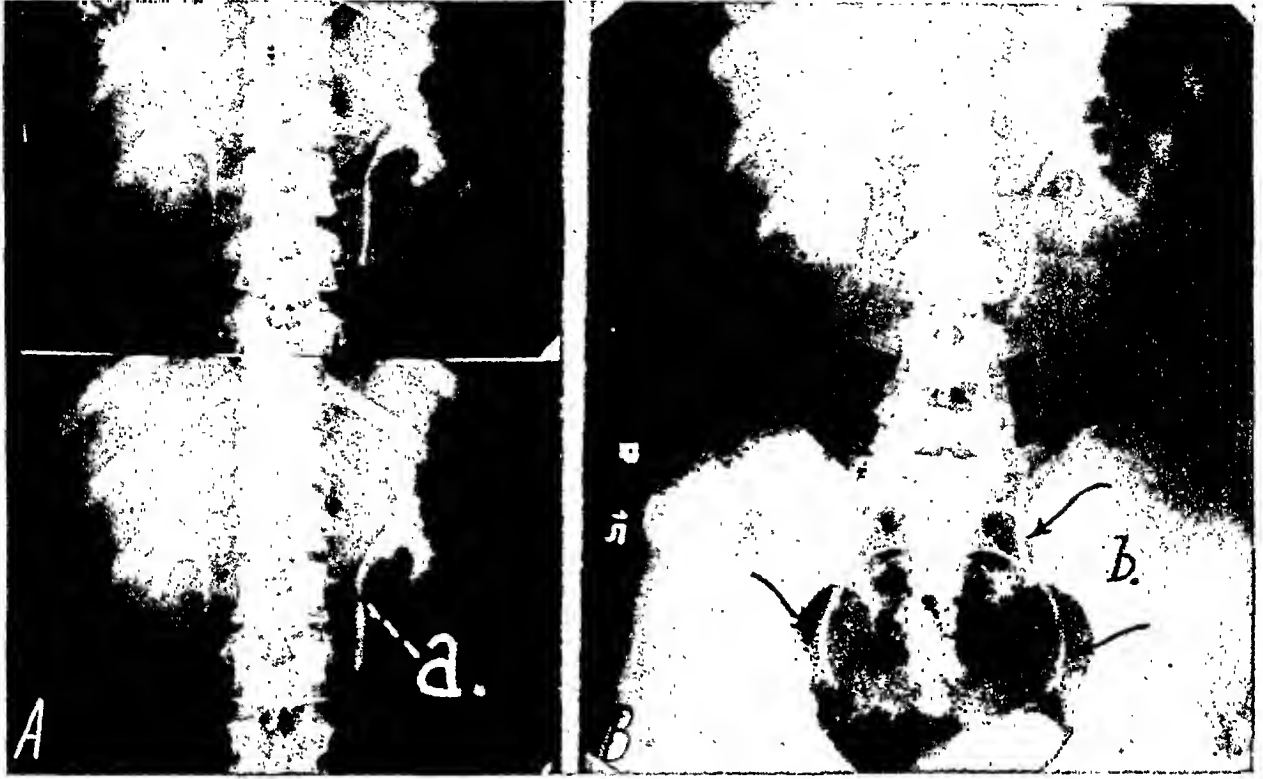


FIG. 1. Normal intravenous urogram. *A*, stereoscopic views of upper collecting system made during compression are shown at *a*. *B*, at *b*, shows very satisfactory filling of the lower ureters usually seen in urograms made immediately after removal of compression.

then made for a 14 by 17 inch film and the exposure made immediately after releasing the pressure. In this roentgenogram *the entire tract is usually most satisfactorily visualized, especially the distal halves of the ureters* (Fig. 1). If there is the possibility of a stone in the lower third of either ureter or some abnormality of the bladder, we then make 8 by 10 inch stereoscopic roentgenograms of this region using a transverse shift of the tube. At about this time the roentgenogram made at the five minute period may be seen and from this examination further requirements in the individual case can usually be determined. If normal excretion and drainage are taking place on each side a roentgenogram is then made with the patient

Each of these roentgenograms is examined immediately after it is developed and fixed, and further roentgenographic requirements thus determined. If satisfactory visualization of one or both sides has not taken place during the first hour, roentgenograms are then made at thirty minute intervals until satisfactory filling has taken place. If there is no evidence of any excretion within two and one-half hours following the injection the examination is terminated. It is not uncommon in an apparently non-functioning kidney first to visualize the structures on the affected side as late as two or even two and one-half hours after the injection and as a result to obtain invaluable diagnostic data (Fig. 2).

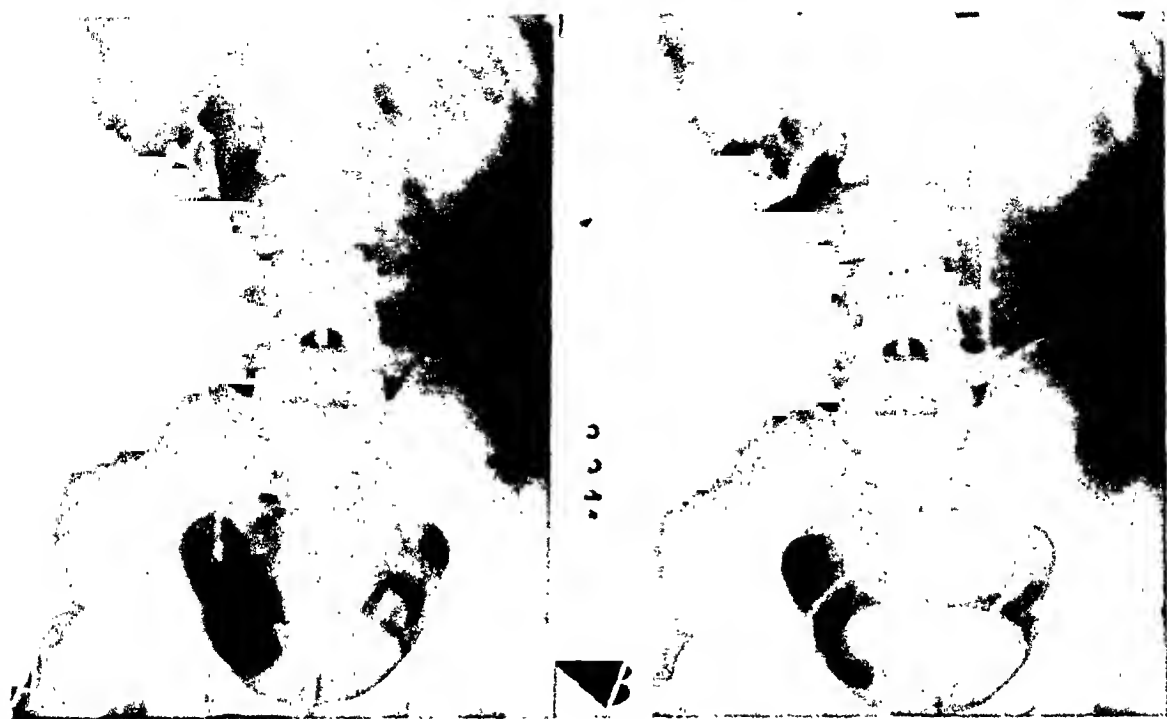


FIG. 2. Tiny stone at junction of left ureter with bladder. *A* shows normal function and drainage of right kidney and ureter. Almost no evidence of opaque material seen on the left. *B* was made forty-five minutes after injection. Almost complete emptying of pelvis and ureter on the right. Interference with drainage of left ureter at junction with bladder, dilatation of ureter, pelvis and minor calices are well shown. Stone passed spontaneously twenty-four hours later. Urinary tract to be re-examined later, but it will undoubtedly be normal.

Our technique of intravenous urography is graphically illustrated in Figure 3. The position of the patient, roentgen tube, Potter-Bucky diaphragm, compression band and cassette are shown, together with the time interval between exposures. In practice, compression is rarely maintained for more than from five to seven minutes.

Accurate interpretation of findings in intravenous urography requires a sound basic knowledge of urinary tract morphology and physiology in health and disease and the corresponding roentgen manifestations. Further requirements are accurate observation, experience and sound judgment. The roentgenologist in his interpretation must always keep in mind the limitations of the diagnostic aid employed. He must not draw conclusions unjustified by his findings and must always be ready to work with the referring physician, sharing responsibility in arriving at the proper diagnosis.

*Retrograde Urography.* Retrograde urography continues to have an important place in the study of disturbances of the urinary tract. There is no conflict between the retrograde and intravenous methods. Each has advantages in certain conditions and one supplements the other in many cases. In retrograde urography we believe that best results are secured when the radiologist assumes the direction of the roentgenographic phase of the examination, and the interpretation of the roentgen findings is his responsibility.

*The Use and Value of the Roentgenoscope in Retrograde Urography.* During the past year an increasing number of our retrograde urograms have been done under roentgenoscopic guidance. This was begun in a case with marked pelvic dilatation where the urologist was anxious to secure complete filling. The results were so satisfactory and the method so simple that more and more cases have been done in this manner.

The equipment required is only that already available in most modern hospitals. In our hospital, after ureteral catheterization in the urological section on the sixth floor, the patient is brought to the roentgenographic department on the first floor. He is then placed on the horizontal roent-

injection, stereoscopic roentgenograms of the entire tract are made in the conventional manner and frequently a lateral view with the side under suspicion nearest the cassette.

The following history and findings in the case shown in Figures 4 and 5 illustrate the

## SIMPLE METHOD OF INTRAVENOUS UROGRAPHY YIELDING MAXIMUM INFORMATION IN THE SHORTEST POSSIBLE TIME.

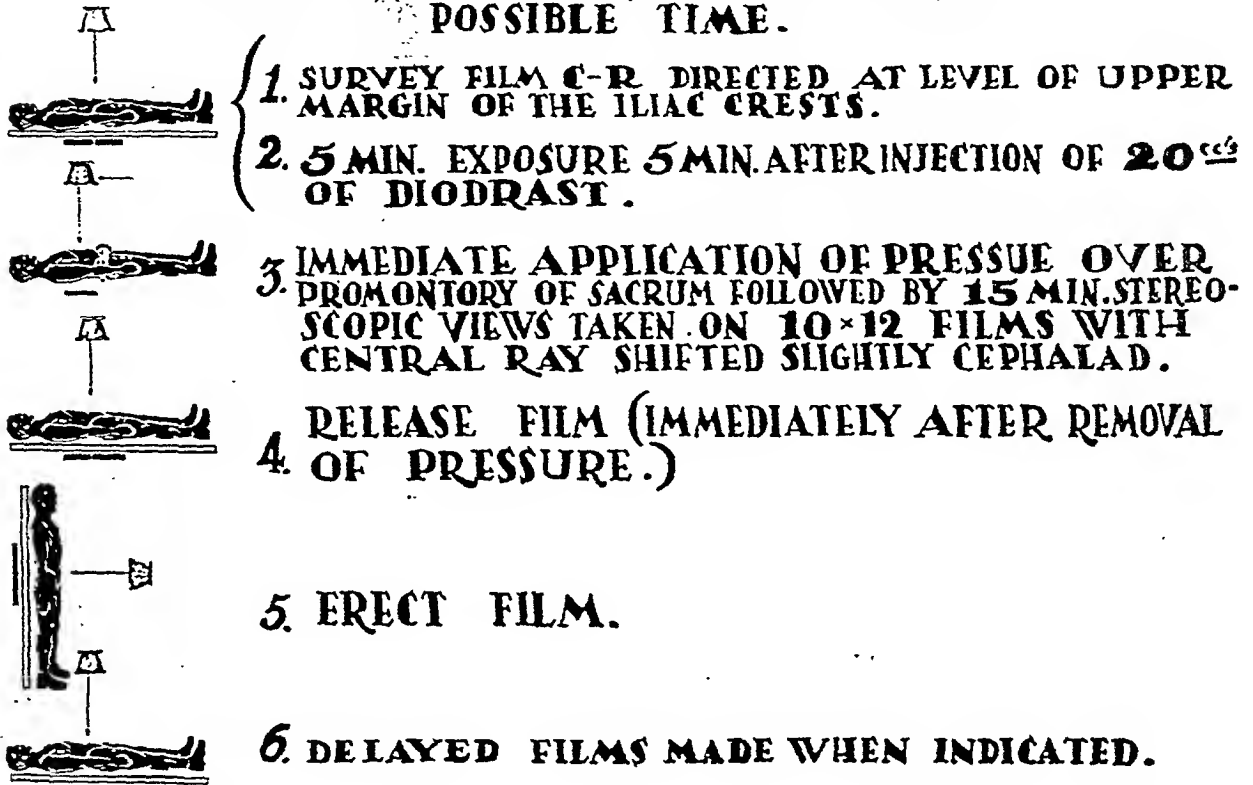


FIG. 3. Chart of method of intravenous urography showing position of patient, cassette, tube and compression apparatus together with exposure intervals.

genographic-roentgenoscopic table, the eyes of the roentgenologist having been accommodated in the meantime.

The contrast medium is introduced by the urologist with the aid of roentgenoscopic guidance by the radiologist. Care is taken to obtain complete filling without over-distention by careful observation of the screen image and the patient's reaction to the injection. By means of a spot film device on our machine, irritability of any part of the tract observed can readily be recorded with repeated exposures. Similarly any other abnormality seen can instantaneously be recorded. After completing the

importance and value of the above type of examination.

**CASE I.** This patient was operated on for bilateral undescended testicles in 1935. A mass developed in the left side of the scrotum while on overseas duty. A left orchidectomy was done in an overseas hospital. The histopathological report stated that the tumor was a teratoma. Convalescence was uneventful and the patient was referred for deep radiation therapy.

An intravenous examination of the urinary tract revealed poor visualization of the left upper collecting system. Retrograde filling under roentgenoscopic guidance was then done and showed an extreme degree of spasm of the calices. The proximal portion of the ureter was

irregular in contour and seemed to be somewhat displaced posteriorly. Serial exposures of the kidney area (Fig. 4) were made, proving that the irregularity in filling of the minor calices was due to spasm and not to organic destructive changes.

The patient was re-examined seven weeks later following deep roentgen therapy. Marked

A survey of old and recent literature will reveal that fluoroscopic visualization of the upper urinary tract upon retrograde filling is generally condemned. The chief objections appear to be that the method is too time consuming and difficult, that most examiners have inadequate facilities and that serial urograms will give more accurate data in delineating de-

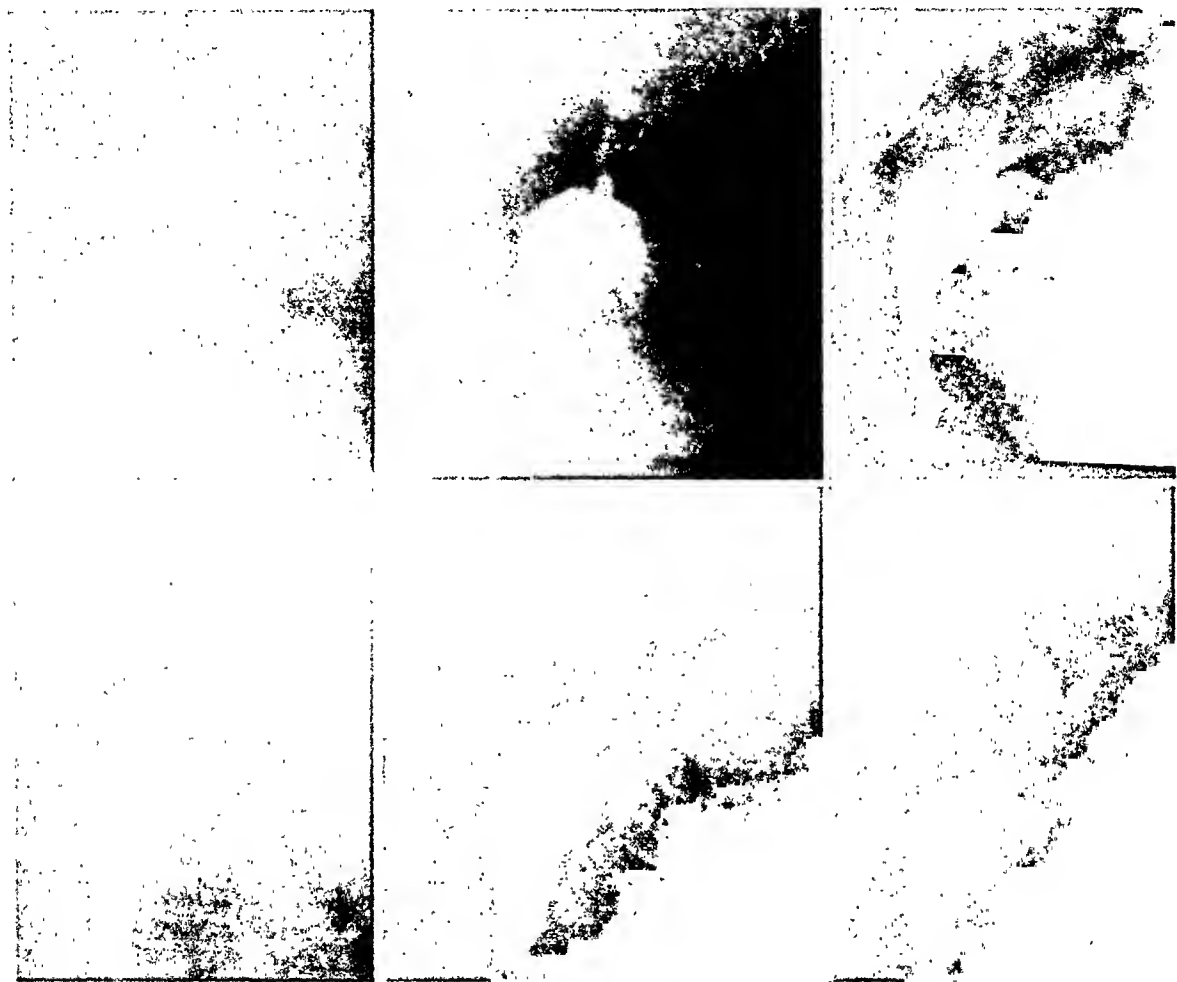


FIG. 4. Case 1. Testicular tumor. Spot roentgenograms of upper collecting system showing marked spasm of calices.

improvement had taken place as is shown in Figure 5B. The mechanism of the spasm of the calices is not known, there being no evidence of infection and no bleeding. It is quite possible that there were metastases in the region of the renal pelvis accounting for the deformity of the proximal portion of the ureter at *x* (Fig. 5A) and if so these metastases may have been responsible in some way for the caliceal spasm.

One of us (H. J. H.) has the following to say of this method of examination:

tailed morphology and physiology. In our group the decision to carry out fluoroscopic visualization in selected cases has been a happy one. All of the above objections have been overcome. Excellent anatomical detail is obtained and constant filling defects are readily demonstrated. The method has been particularly valuable in the demonstration of retroperitoneal lesions and other pathological conditions which lie adjacent to the urinary tract and cause rotation, displacement and other deviations from normal. Re-examination due to in-

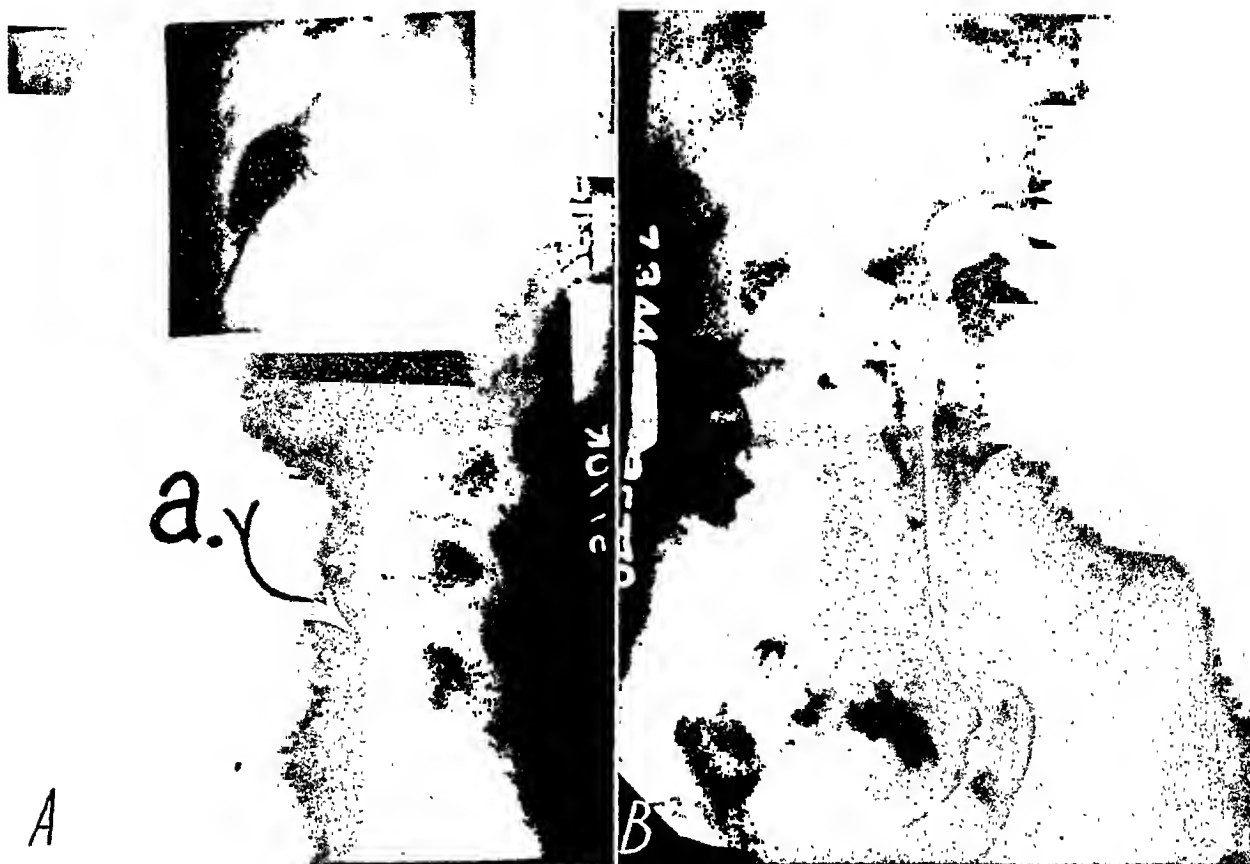


FIG. 5. Case 1. Testicular tumor. *A*, spastic deformity of calices, and apparent slight displacement and angulation of ureter at *a*. *B* shows improvement following radiation therapy.

complete filling is almost entirely eliminated. Painful reactions which often follow overdistention are avoided.

The late Willis F. Manges advocated the use of the roentgenoscope in retrograde urography almost thirty years ago. Those interested in this method of examination should be familiar with his excellent paper entitled "Pyeloscopy."<sup>4</sup>

*The Lateral Urogram.* Mertz and Hamer,<sup>5</sup> Shiflett and Keith,<sup>9</sup> and others, have described this method of examination and have emphasized its value in the diagnosis of various conditions, particularly retroperitoneal lesions adjacent to some part of the urinary tract and perinephritic absces-

ses. We have seen one perirenal abscess in which this method of examination was of decided aid in diagnosis.

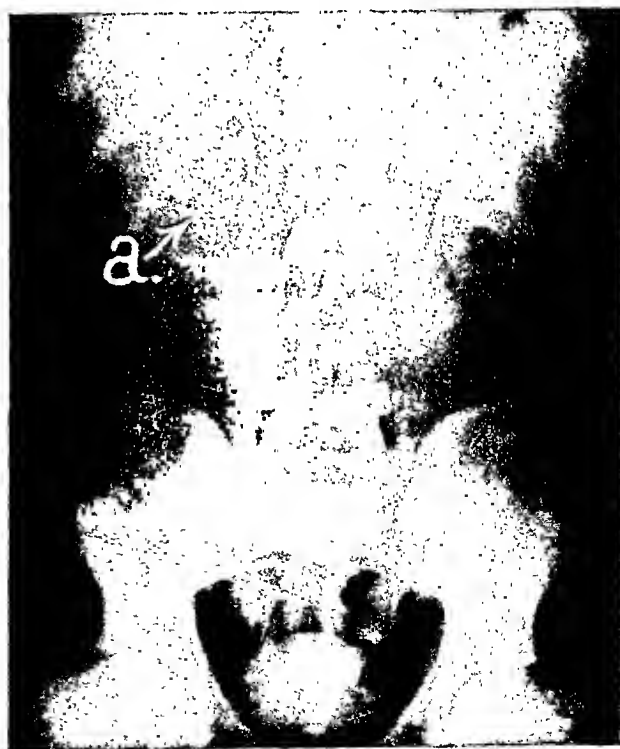


FIG. 6. Case II. Perinephritic abscess. Intravenous urogram showing marked cephalic displacement of upper collecting system on right indicated at *a*. Slight curvature of lumbar spine, concavity on right. Psoas shadow on right, obscured. Structures on left, normal.

**CASE II.** This twenty-six-year-old prisoner of war was admitted to the Percy Jones General and Convalescent Hospital with a history of chills and fever three weeks prior to admission, lasting for six days. He was well for a week then developed pain in the right upper quadrant with elevation of temperature. Physical examination showed resistance to palpation in the right upper abdomen. The sedimentation rate was normal in the first hour. The urine was normal. The roentgenological examination showed a curvature of the lumbar spine, the concavity being on the right. The margin of the gall shadow in the right renal area could not be seen. An intravenous urogram revealed the right kidney to be unusually high, the lower pole appearing to be displaced anteriorly. The findings are shown in Figure 6. A roentgen diagnosis of perinephritic abscess was made. At operation approximately 8 ounces of creamy pus was found about the lower pole of the kidney. The infecting organism was the

organism, *Staphylococcus aureus*. The postoperative course was uneventful. Retrograde examination of the urinary tract was done after recovery. The kidney was still elevated, but the position of the lower pole was normal. The findings are shown in Figure 7.

In our work, the lateral urogram has been of greatest value in the diagnosis of metastases about the renal pedicles in individuals with testicular tumors and in the demonstration of mass lesions adjacent to some part of the urinary tract in Hodgkin's disease and other lymphomas as well as in the leukemias. Satisfactory roentgenograms in the lateral projection can seldom be secured during intravenous examination unless there is interference with emptying of the distal part of the ureter on the affected side. In most of our cases the retrograde method has been employed. The up-

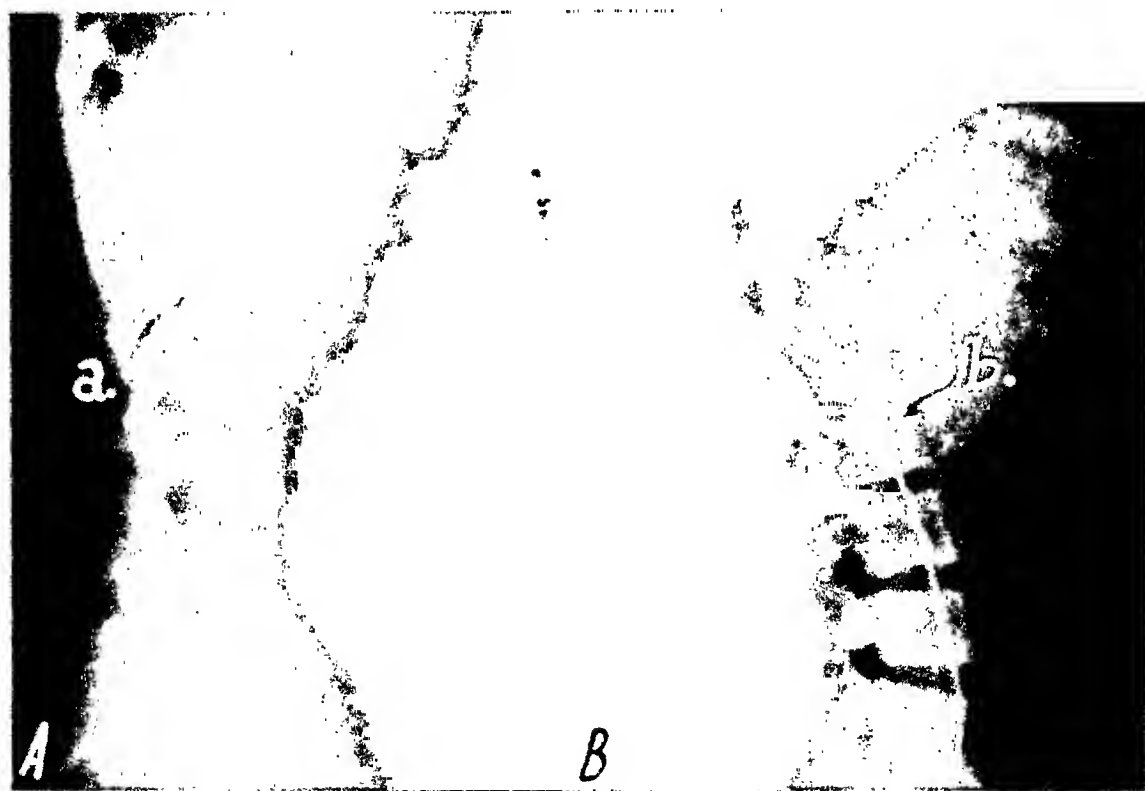
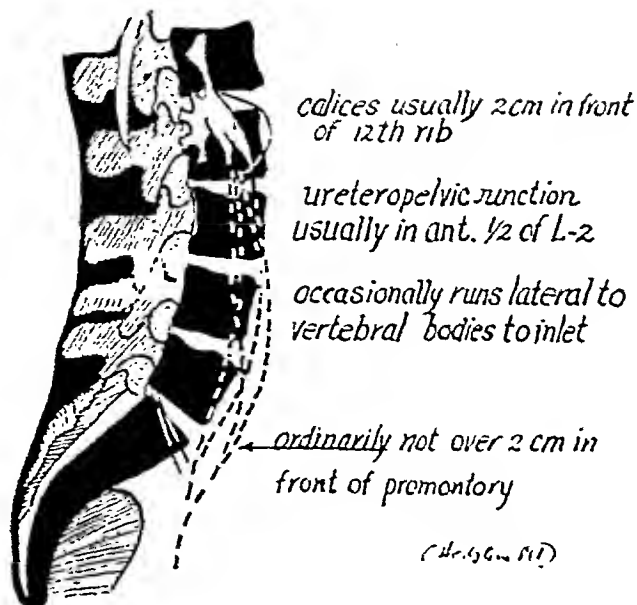


FIGURE 6. The roentgen diagnosis of the abscess about the right kidney with anterior displacement of the lower pole is shown in A, retrograde catheterization of the ureter at *a*. This lateral view was made during an intravenous examination. The retrograde method is sufficiently well shown to be of value in diagnosis. B, lateral view of the right kidney retrograde catheterization showing distention of perinephritic abscess, and after contraction of the abscess the position of the kidney is noted except that the kidney has higher than is normally to be expected.



per collecting system is filled under roentgenoscopic guidance and stereoscopic roentgenograms made in the anteroposterior position using a tube shift transverse to the ureter. The patient is then turned into the lateral position with the affected side down, *great care being taken to secure a true lateral projection.* A relatively short exposure is desirable. We have found that 100 milliamperes-seconds at approximately 88 kilovolts (peak) with a 36 inch focal distance is adequate in patients of average size. Normally in this projection the right kidney pelvis and calices usually lie lateral to the body of the second or third lumbar vertebra, the left being somewhat higher. The ureter passes downward and ventralward and emerges anterior to the spinal column at about the level of the fourth lumbar vertebral body (Fig. 8). There are some normal variations in the position of the kidney and ureter. These should be kept in mind. Mass lesions may displace or cause horizontal or



### Normal course ureters (lateral projection)

FIG. 8. Composite drawing by one of us (G.W.H.) showing position of right kidney pelvis and ureters in relationship to the lumbar vertebral bodies in a series of patients where the findings were considered to be within normal limits.

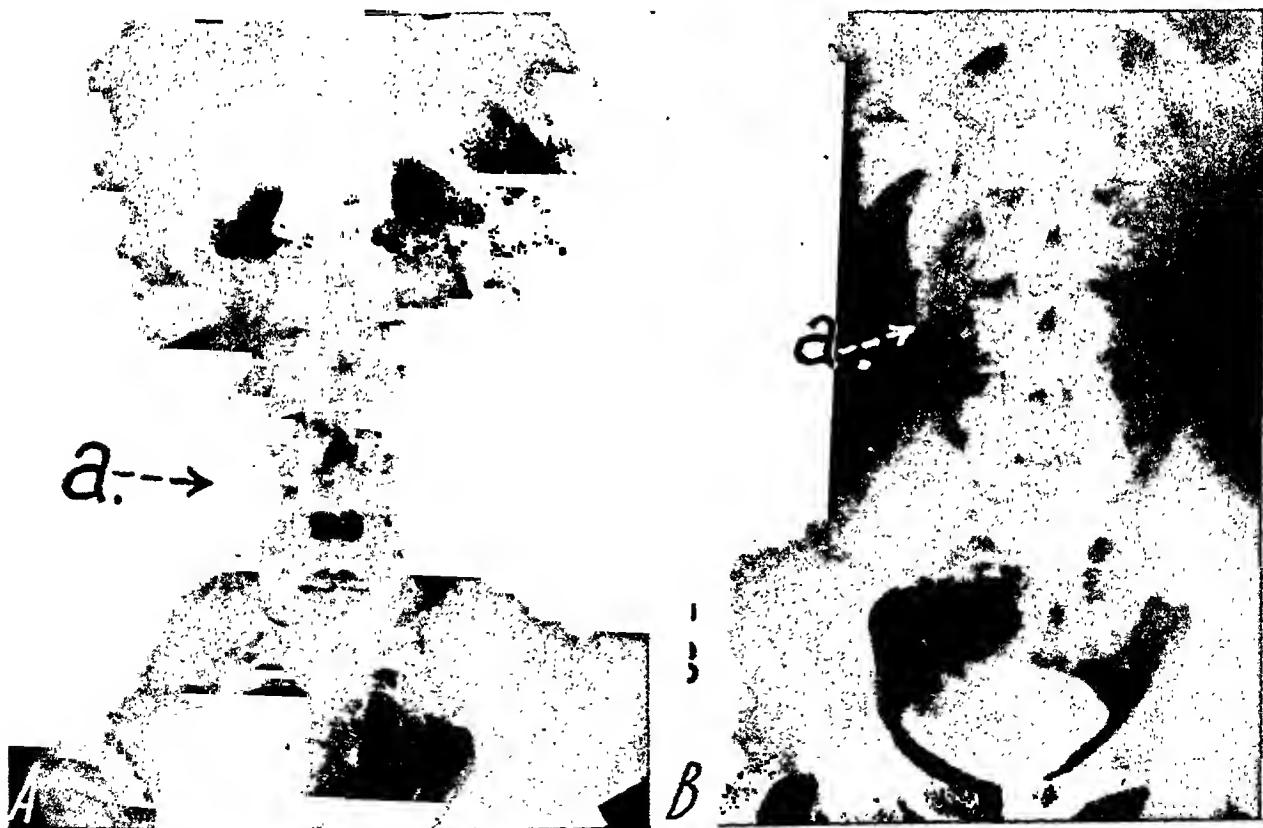


FIG. 9. Obstructing stone, right ureter. *A*, fifteen minute urogram shows stone in middle third of right ureter at *a*. Interference with drainage on right. Moderate dilatation of pelvis and calices. Normal excretion and drainage on left. *B*, sixty minute urogram shows complete emptying of pelvis and ureter on left. Obstruction of right ureter by stone at *a* with secondary dilatation proximal to stone well shown.

vertical rotation of the kidney and or antero-posterior, postero-anterior or lateral displacement of the ureter.

#### OBSTRUCTIONS OF THE URINARY TRACT

The causes of high obstructions are well known. The common ones are stones (Fig. 9, 13 and 14), aberrant vessels or other congenital malformations (Fig. 12 and 17) and mass lesions adjacent to the ureteropelvic junction.

**CASE III.** This twenty-two year old white soldier was admitted to the Neuro-surgical Service in May, 1944. He was struck in the back by a shell fragment in January, 1943, while engaged in action against the enemy. The wound resulted in a complete paraplegia below the eleventh dorsal dermatome. Fifteen hours later the wound was explored and two days later suprapubic cystostomy was performed because of overwhelming incontinence of urine. He first

developed symptoms of an infection of the urinary tract in March, but an intravenous urogram done at that time revealed no abnormality.

Upon admission here, there was some return of sensory and motor function in the lower extremities. The bladder had a capacity of approximately 60 cc. and infection was present. Tidal vesical irrigation was instituted as was supplemental chemotherapy. The suprapubic tube, and later the urethral catheter, was removed. The patient did well for a few days and then developed a high fever associated with severe pain in the left renal region. The roentgen examination of the urinary tract is illustrated in Figure 11. There were stones in the left kidney area, one of which lay at the junction of the pelvis with the ureter. The intravenous examination showed normal function on the right and marked impairment in excretion on the left. Only after a long period of delay was the upper collecting system faintly visualized on the left and it was obvious that the



FIGURE 11. Obstructing stone, right ureter. Catheters were passed by obstructing stone shown in Figure 9, which was removed by cystostomy. Patient free from symptoms for a few days then again developed symptoms. A, intravenous urogram was made at this time. It shows quite marked obstruction of the ureter at its junction with the pelvis, the stone being shown in the latter area. Secondary dilatation proximal to point of obstruction. Stone extracted by trans-rectal manipulation. Recovery prompt. B, intravenous urogram made after stone was removed. Function and drainage normal on each side.



FIG. 11. Case III. Multiple stones, left kidney area and bladder. *A* shows defects in posterior arches of lower dorsal and upper lumbar region resulting from gunshot wound and operation, at *a*. Function on left markedly impaired. Stones in bladder indicated at *d* found imbedded in anterior wall of bladder at site of previous cystostomy. *B* shows rather faintly the upper collecting system on the left two and three-quarter hours after the administration of diodrast, at *e*. Stone at junction of pelvis with ureter indicated by lowest arrow is obviously causing marked obstruction and marked impairment of left renal function.

stone at the junction of the pelvis with the ureter was causing a high degree of obstruction.

There were two stones in the bladder area that were of interest. They were shown in stereoscopic roentgenograms to lie far anteriorly. At first they could not be found at cystoscopy, but later were shown to be imbedded in the anterior wall of the bladder at the site of the old suprapubic cystostomy.

The patient continued to show marked evidence of sepsis and the left renal area was explored, a purulent pyelonephritis being found and a nephrectomy done. The patient made a good recovery and is now ambulatory and voiding normally.

**CASE IV.** This white soldier, aged forty-three, was admitted following evacuation from an overseas theater. He was hospitalized overseas chiefly because of a traumatic bursitis of the right elbow. A careful review of his history revealed only a mild mid-lumbar back pain with no radiation. Pain was dull in character and was increased with activity. The urine was normal

at all examinations. An excretory urogram was done and a marked right hydronephrosis demonstrated. Figure 12*A* was made with the patient upright during intravenous urography. Fluid levels in markedly dilated calices on the right are well shown. A retrograde examination was considered advisable and the findings are illustrated in Figure 12*B*. The pelvis is markedly dilated as are the minor calices. The proximal part of the ureter is displaced, the changes being quite characteristic of those seen in the presence of aberrant vessel which is causing a high degree of obstruction. The patient was separated from the service without operative confirmation.

Obstructions of the lower urinary tract likewise are commonly caused by stones (Fig. 2 and 10), congenital malformations, strictures, primary bladder lesions such as tumors (Fig. 13) or diverticula (Fig. 14), and acute and chronic cystitis (Fig. 15 and 16). Delay in emptying of the ureters with dilatation may also be neurogenic or adnexal in origin.

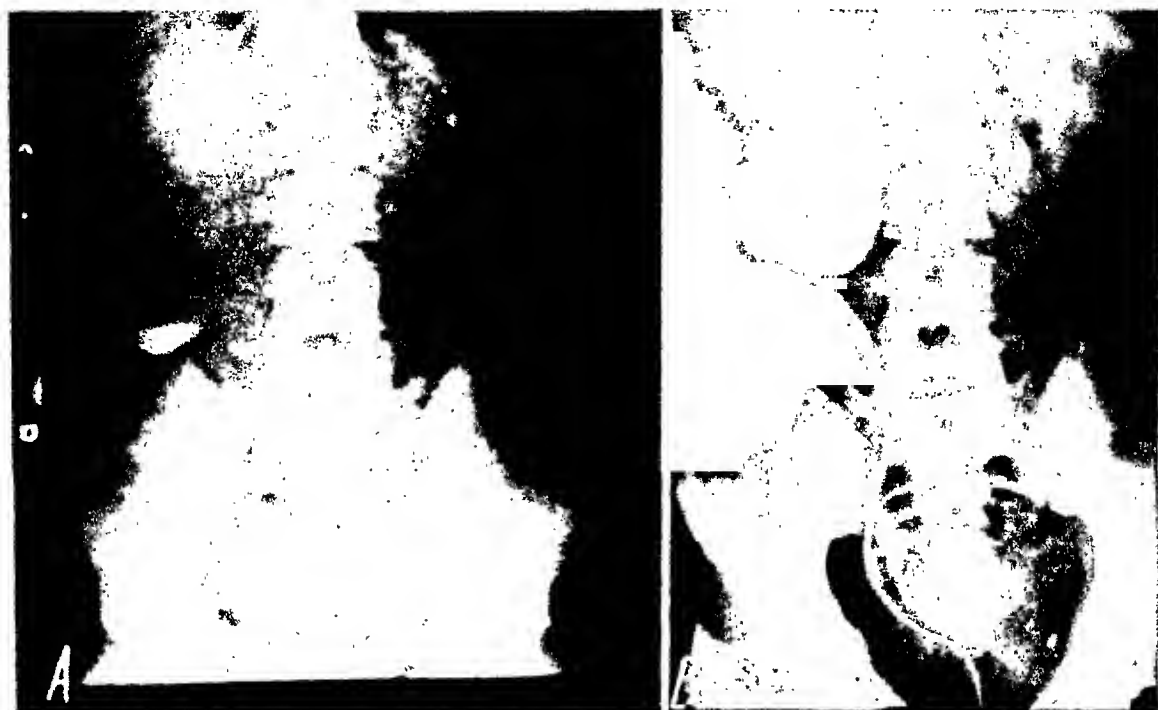


FIGURE 12. Case 15. Obstruction at ureteropelvic junction, probably due to aberrant vessel. *A*, thirty minute intravenous pyelogram made with patient upright. Fluid levels in markedly dilated minor calices are well shown. *B*, retrograde filling of upper collecting system done with roentgenoscopic guidance. Pelvis and calyces are greatly dilated. Ureter displaced lateralward, probably due to presence of aberrant vessel.



FIGURE 13. Case 16. *A*, retrograde pyelogram, very satisfactory. Deformity due to previous surgery. *B*, retrograde ureter shown at *B*. Markedly dilated right ureter and right calyces. *C*, retrograde pyelogram, very satisfactory. Impairment in function, more marked on right



FIG. 14. A diverticulum of bladder with moderate interference to emptying of ureters. Patient was a white soldier, aged twenty-three. Transfer diagnosis: ulcer of bladder, probably malignant. History of urinary frequency and difficulty in urination early in adult life. Acute neisserian urethritis complicated by prostatic infection in 1940. Marked urinary frequency and urgency since then with pain in perineum when bladder was distended. Cystoscopy demonstrated severe hemorrhagic cystitis with no evidence of a malignant tumor, and partial obstruction of the bladder neck due to a congenital fold as well as hypertrophy of the musculature. The two intravenous urograms shown at the top reveal a large diverticulum of the bladder. This was confirmed at cystoscopy. Retrograde air and opaque cystograms shown at the bottom. Transurethral resection of bladder neck obstruction done. Patient is convalescing satisfactorily. Diverticulum to be excised later if necessary.

than left. *B*, part of opaque retrograde cystogram. Defect in bladder due to tumor indicated by arrow. Reflux of contrast medium outlines left ureter. *C*, air cystogram made immediately after withdrawal of contrast material used in opaque cystogram. Tumor projecting into bladder at *c* is well demonstrated.

CASE V. This white soldier, aged eighteen, had been free from any urinary symptoms until July, 1944, shortly before induction into the Army. At this time he noted a profuse urethral discharge. He consulted a physician who told him that the discharge was non-venereal in origin and administered sulfanilamide medication. After a few days severe urinary urgency, frequency and dysuria appeared. He was given



FIG. 15. Case v. Acute cystitis and posterior urethritis. Sixty minute intravenous urogram. Markedly contracted and irregular bladder shown at *a*. Ureters are dilated. Dilated kidney pelvises and minor calices indicated at points *b*.

local intraurethral therapy without benefit and gross hematuria developed. He was hospitalized almost immediately following induction because of his severe urinary symptoms.

Upon admission to the Percy Jones General and Convalescent Hospital examination demonstrated tenderness in the suprapubic area. There was evidence of prostatitis and seminal vesiculitis upon rectal palpation. Microscopic examination of the urine revealed innumerable

red and white blood cells. Culture of the urine showed non-hemolytic *Staphylococcus aureus*.

Cystoscopic examination showed a very severe diffuse hemorrhagic cystitis and posterior urethritis. The capacity of the bladder was approximately 30 cc.

An excretory urogram was made. During the early part of the examination no evidence of opaque material could be seen. The tract was first satisfactorily visualized sixty minutes after the injection and the findings are illustrated in Figure 15. As will be seen, the bladder is markedly contracted and decidedly irregular in outline and the ureters are quite markedly dilated. The changes were considered to be the result of an unusually severe acute cystitis.

Therapy consisting of sulfadiazine, 1 gram every four hours, together with continuous irrigation of the bladder with a solution of lactic acid of increasing strength was instituted. The urinary symptoms subsided rapidly and the irrigation was discontinued after a period of one week. A residual infection of the seminal vesicles and prostate was treated. Three weeks following the beginning of treatment there was no evidence of infection in the genitourinary tract. An excretory urogram was made at this time. It showed normal excretion of the dye. The drainage of the ureters was free. The bladder was entirely normal in appearance. The findings are illustrated in Figure 16.

In such obstructions the intravenous examination is of primary importance and when continued over a sufficient period of time yields information of great value. Retrograde examinations are frequently also necessary in securing detailed information where the intravenous examination may indicate only the presence of some abnormality without resulting in satisfactory visualization of the part or parts under suspicion (Fig. 17). In a significant number of these cases roentgenoscopic guidance in filling is of definite value.

CASE VI. This white soldier, aged twenty-six, was admitted in March, 1944, with a diagnosis of left hydronephrosis. He had had scarlet fever without apparent complications in early childhood. Three years ago he suffered from gross hematuria accompanied by pain in the left upper abdomen for a few days. He was well until a few days before admission when he was

hospitalized because of chills and fever accompanied by gastrointestinal disturbances. Gross hematuria then reappeared together with pain in the left costovertebral region.

Physical examination revealed tenderness in the left upper quadrant and left costovertebral region. The kidney could be palpated. The blood pressure was normal. The urine contained innumerable white and red blood cells.

dilated pelvis is indicated at *b*. The point of obstruction in the ureter at its junction with the kidney pelvis is indicated at *c*.

The value of retrograde filling is demonstrated in this case showing a marked degree of dilatation present which was only suggested by the intravenous examination.

The patient continued to suffer from pain, chills and fever that was as high as 104° F. at

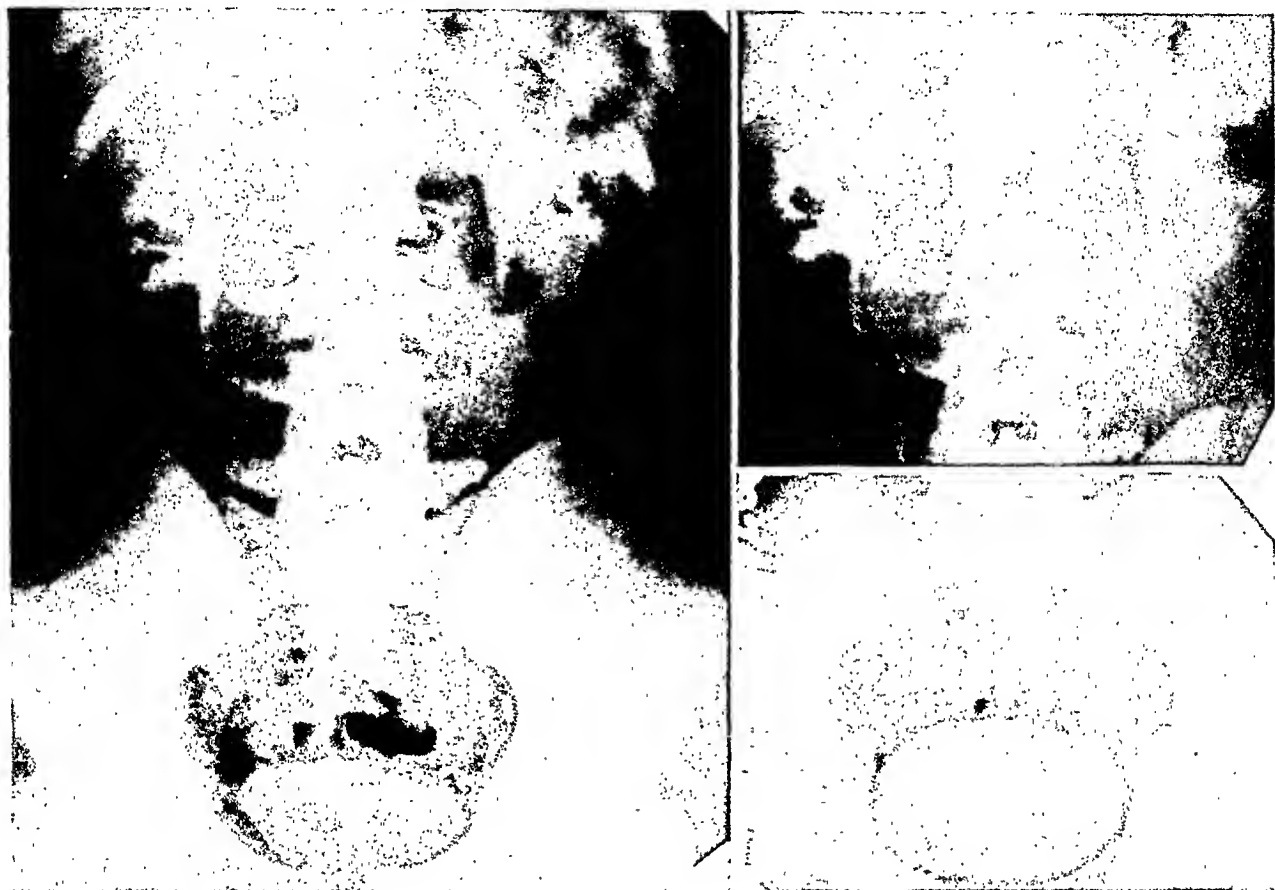


FIG. 16. Case v. Acute cystitis and posterior urethritis. Illustrations from intravenous examination done three weeks after beginning of treatment. Excretion and drainage are now normal. Dilatation has disappeared. Bladder shadow well shown and is entirely normal in appearance. Patient free from symptoms and evidence of disease at this time.

Culture showed non-hemolytic *Staphylococcus aureus*. The blood sedimentation rate was elevated and a definite leukocytosis was present.

An intravenous urogram was made. The structures on the right were quite well shown, but on the left they were not so well outlined and it was obvious that there was marked dilatation of the kidney pelvis and calices. The findings are shown in Figure 17*A*. The dilated pelvis is indicated at *a*. A retrograde urogram was considered to be indicated and filling was done under roentgenoscopic guidance. Our findings are shown in Figure 17*B*. The markedly

times. Catheterization of the left renal pelvis resulted in no improvement. An exploration of the renal area was done on April 4, 1944. About 400 cc. of purulent urine was aspirated from the left kidney. There was a relatively large aberrant vessel that crossed in front of the ureter at its junction with the kidney pelvis, apparently causing the obstruction. A marked perinephritis was present, as were numerous areas of cortical suppuration. A nephrectomy was done. Penicillin was administered and the post-operative course was uneventful. The patient is now clinically well. The urine is normal. The soldier was returned to duty May 24, 1944.



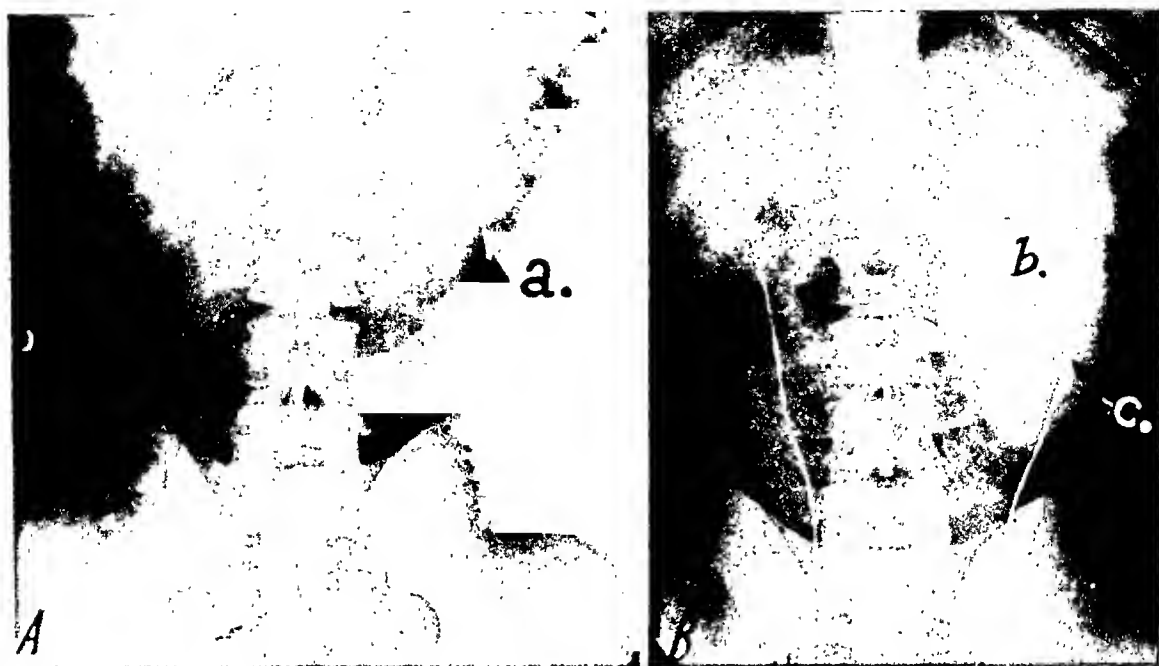


FIG. 17. Case vi. Marked pyelectasis with secondary pyelonephritis due to obstruction from aberrant vessel. *A*, forty-five minute intravenous urogram. Excretion on right, satisfactory. Pelvis moderately dilated. Some stasis is probably present. Excretion on left impaired. Minor calices deformed. Pelvis obviously markedly dilated, but only a suggestion of dilatation is demonstrated. Above findings shown at *a*. *B* shows retrograde filling of left kidney pelvis done under roentgenoscopic guidance. Tremendously dilated pelvis indicated at *b*. Point of obstruction due to aberrant vessel shown at *c*. Nephrectomy was done largely because of the marked destructive infectious changes in this kidney.

#### RENAL TRAUMA

Following renal injuries, the intravenous examination has proved to be of decided value. One may demonstrate the sequelae of trauma such as rupture of various parts of the urinary tract and at times show displacement of some portion of the collecting system resulting from hemorrhage or extravasation of urine. Retrograde examinations are necessary in some traumatic lesions and may yield detailed information not demonstrable by other methods. *Frequent follow-up examinations are always indicated.*

It is important to examine the surrounding structures carefully, particularly the chest and gastrointestinal tract in individuals who have suffered renal trauma (Fig. 18 and 19), especially following gunshot wounds.

**CASE VII.** This patient was admitted with a diagnosis of a supradiaphragmatic tumor in the right chest found in a routine roentgen examination in preparation for overseas duty. The

patient had had an injury when struck by a bicycle in 1933. He was hospitalized complaining of pain in the lower right chest and abdomen. A microscopic hematuria was present for five days. Fractures of the right tenth, eleventh, and twelfth ribs were said to have been demonstrated at this time. The patient recovered promptly and was well until September, 1943, when he was again injured in the lower back and hematuria was noted which persisted for four or five days. A roentgen examination was not done at this time.

When admitted March 1, 1944, the lesion shown in Figure 18 was demonstrated. It did not move with the diaphragm. It was lobulated and was considered to be due to a benign lesion of some type, possibly a neurofibroma. The bony structures of the thorax and spine were examined carefully and were normal. A gastrointestinal examination failed to reveal any evidence of a diaphragmatic hernia or other abnormality.

On March 23, 1944, a thoracotomy was done at which time a cystic mass was found lying immediately above the posterior part of the right

side of the diaphragm. There was an opening through the adjacent portion of the diaphragm and the mass in the chest was found to extend through the opening in the diaphragm. It was removed. The upper pole of the kidney was palpated and seemed to be somewhat irregular.

The postoperative course was uneventful except for the removal of some slightly blood-tinged serum from the right side of the chest

the pelvis, only the lower division now being present. Supporting this was the fact that there was a small pouch-like shadow indicated at *b* which suggested filling of the proximal part of what might have been a divided ureter. The appearance of the pelvis and adjacent ureter is indicated at *c*.

There unquestionably was a rupture of the superior pole of the right kidney in this case,

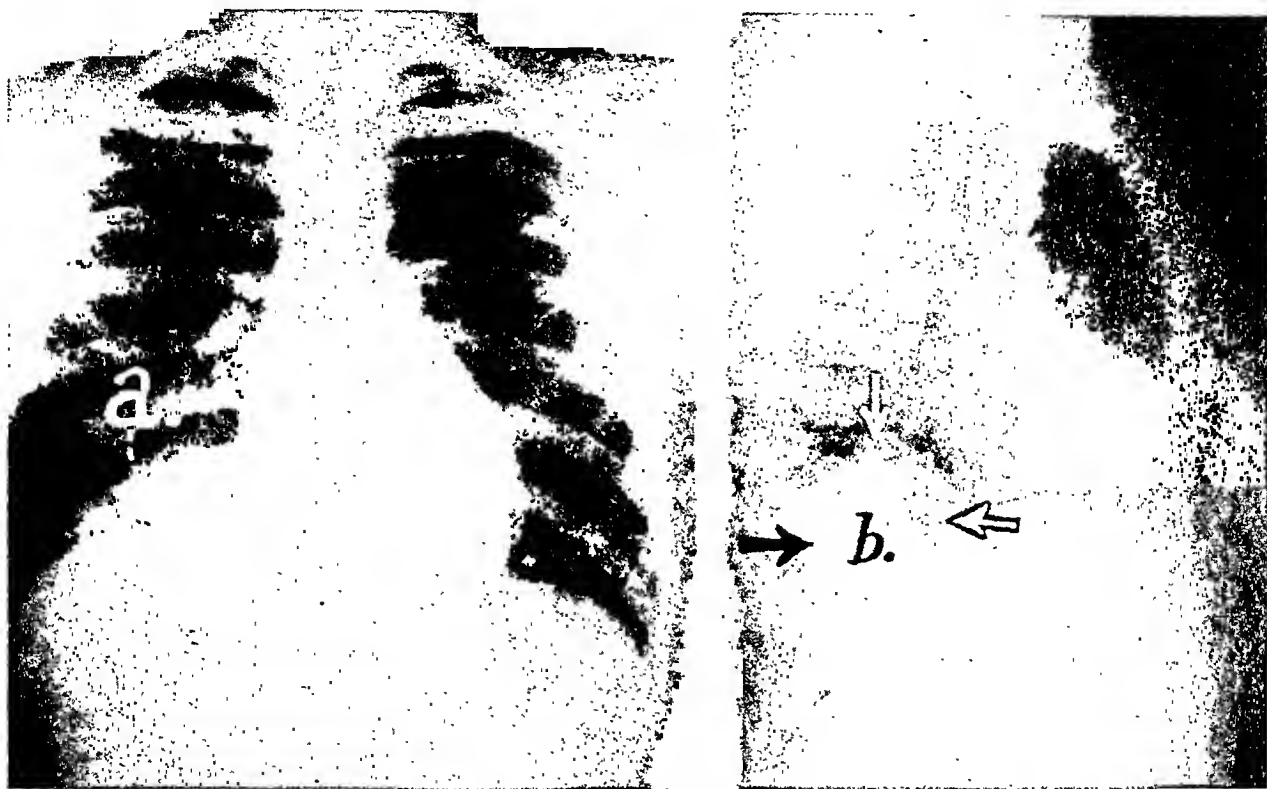


FIG. 18. Case VII. Diaphragmatic hernia, right. Traumatic rupture, right kidney. Fluid containing cyst in posterior part of right side of chest apparently connected with ruptured kidney. *a* and *b* indicate lobulated tumor in posterior right supradiaphragmatic area shown at operation to be cystic in nature and to extend through a rent in the posterior part of the right side of the diaphragm into the right kidney area.

on two occasions. Microscopic hematuria was present for four or five days.

A microscopic examination of the tumor removed showed it to originate from atrophic kidney cortex. What appeared to be a portion of the kidney pelvis was found in the mass.

An intravenous urogram was then done. The findings are shown in Figure 19*A*. The left side of the tract was normal. On the right, however, an irregular mass of opaque material appeared high above the costal margin indicated at *a*. A retrograde examination seemed indicated. It was done under roentgenoscopic guidance. The lateral view is shown in Figure 19*B*. The appearance of the upper collecting system suggested that there had been a reduplication of

but whether or not the pelvis and proximal part of the ureter were divided as a result of a developmental variation from normal cannot be said with certainty although the findings certainly suggest this possibility. The injury apparently caused the traumatic rupture of the diaphragm as well as the injury to the kidney with secondary herniation of a portion of the kidney through the opening in the diaphragm.

The patient's convalescence was uneventful. He has no urinary symptoms at the present time and is now on temporary limited duty. It will remain to be seen whether or not there is a recurrence of renal bleeding.

*Follow-up notes.* The patient returned for re-evaluation on December 5, 1944. Again a mass



FIG. 19. Case VII. Traumatic rupture, right kidney. *A*, five minute intravenous urogram. Excretion and drainage on left, normal. Peculiar collection of opaque material on right shown at *a*. *B*, lateral view of retrograde urogram. *b*, small pocket-like area outlined by contrast medium thought possibly to represent the proximal part of one branch of a divided ureter. Structure at *c* suggests the lower division of a divided kidney pelvis and is obviously the same organ less well outlined by contrast medium at *a*.



FIG. 19C. Case VII. Resected right kidney showing hydronephrotic upper pole to which was attached an atrophic ureter. This apparently proves that there was a reduplication of the pelvis of this kidney and that there had been a traumatic rupture of the superior division.

was seen projecting above the right side of the diaphragm which was very similar to the one demonstrated at this hospital prior to operation in March, 1944.

The patient was transferred to Kennedy General Hospital and operated upon by Major Earl B. Kay. He reports that the operative approach used was transthoracic through the region of the previous operation. A cystic mass was found presenting through the diaphragm that was almost identical to the one found when the operation was performed here at Percy Jones General Hospital. It was densely adherent to both the upper and under surfaces of the diaphragm and was separated with some difficulty. The mass was found to be a part of a hydronephrotic upper pole of the right kidney to which a separate atrophic ureter was attached. The right kidney was removed and the defect in the diaphragm was repaired and closed. The patient had an uneventful post-operative convalescence.

The resected kidney is shown in Figure 19C. The kidney had been opened and the hydro-

nephrotic upper half is shown at the top of the illustration.

#### RENAL AND BLADDER LESIONS

A detailed consideration of primary renal and bladder abnormalities is not within the scope of this communication. Lesions primary in the kidney are frequently well demonstrated either by the retrograde or intravenous method, a combination of the two often yielding information not attainable from one or the other alone. The technique used is identical with that above described.

Abnormalities of the bladder are sometimes well demonstrated in the cystogram obtained during intravenous urography. More often, however, special methods of examination are indicated, retrograde opaque and air cystograms being employed. These are illustrated in Figure 13.

Excellent visualization of a primary renal neoplasm is shown in Figure 20. The differential diagnosis lay between a neoplasm and

solitary cyst. A correlation of the clinical and roentgenographic findings made possible the correct diagnosis.

**CASE VIII.** This officer, white, aged fifty, was admitted for diagnosis in March, 1944, complaining of some pain in the right groin and anterior thigh. The preliminary roentgenogram made before doing a barium enema showed what seemed to be a markedly enlarged right kidney shadow, the lower pole extending below the costal margin. An intravenous urogram was made. The structures on the left were normal. The excretion on the right was excellent, but the middle and inferior calices were elongated and seemed to surround the upper margin of a large mass that extended downward below the level of the iliac crest. A retrograde examination was considered advisable and was done under roentgenoscopic guidance. The findings are shown in Figure 20. A large tumor is shown at *a*, the lower margin of which is outlined by a dotted line. The middle and inferior minor calices seemed to surround the upper pole of the soft tissue mass which was causing medial rotation of the kidney and medial displacement of the proximal portion of the ureter. Figure

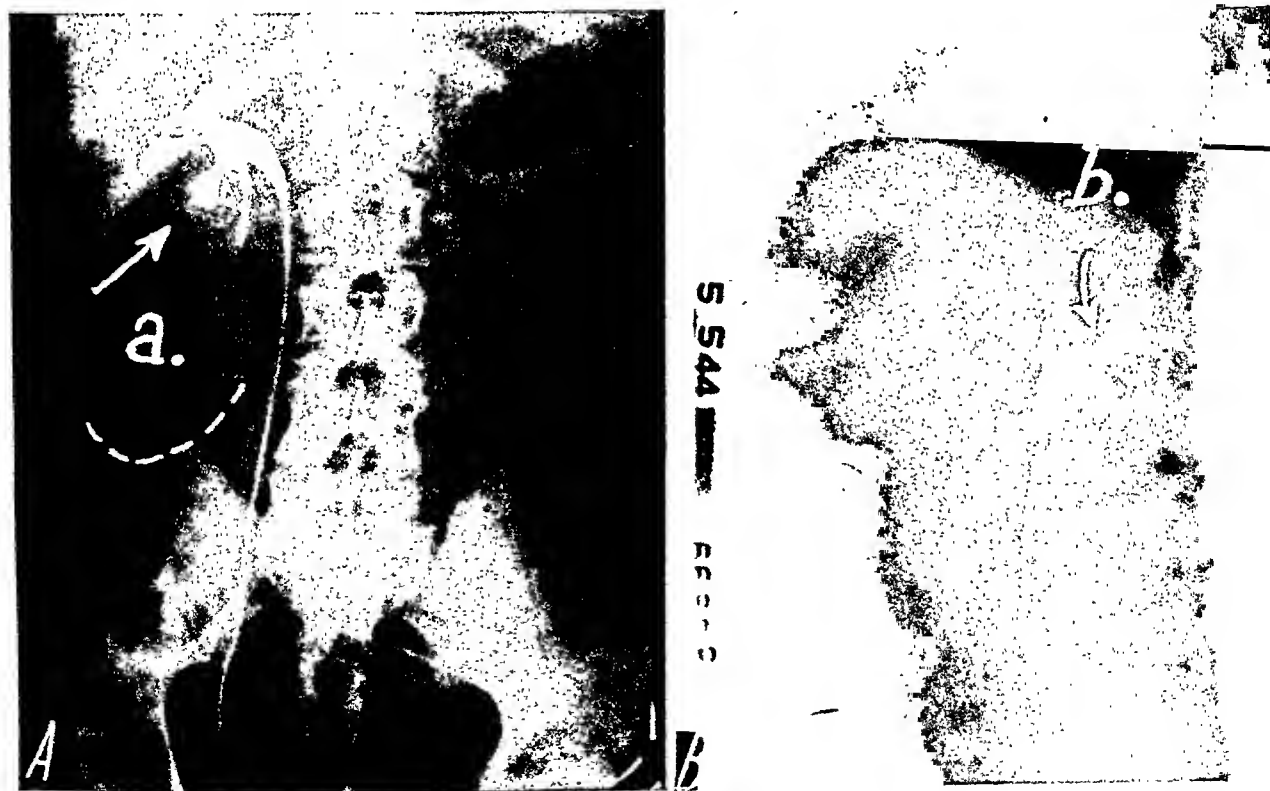


FIG. 20. Case VIII. Adenocarcinoma of lower pole of right kidney. *A* shows a very large tumor at the lower pole of the right kidney, at *a*. Adjacent calices deformed. Kidney rotated. Proximal ureter and pelvis displaced medially. *B*, lateral view; *b* indicates displacement of middle and inferior calices. Both horizontal and vertical rotation of the kidney is demonstrated.

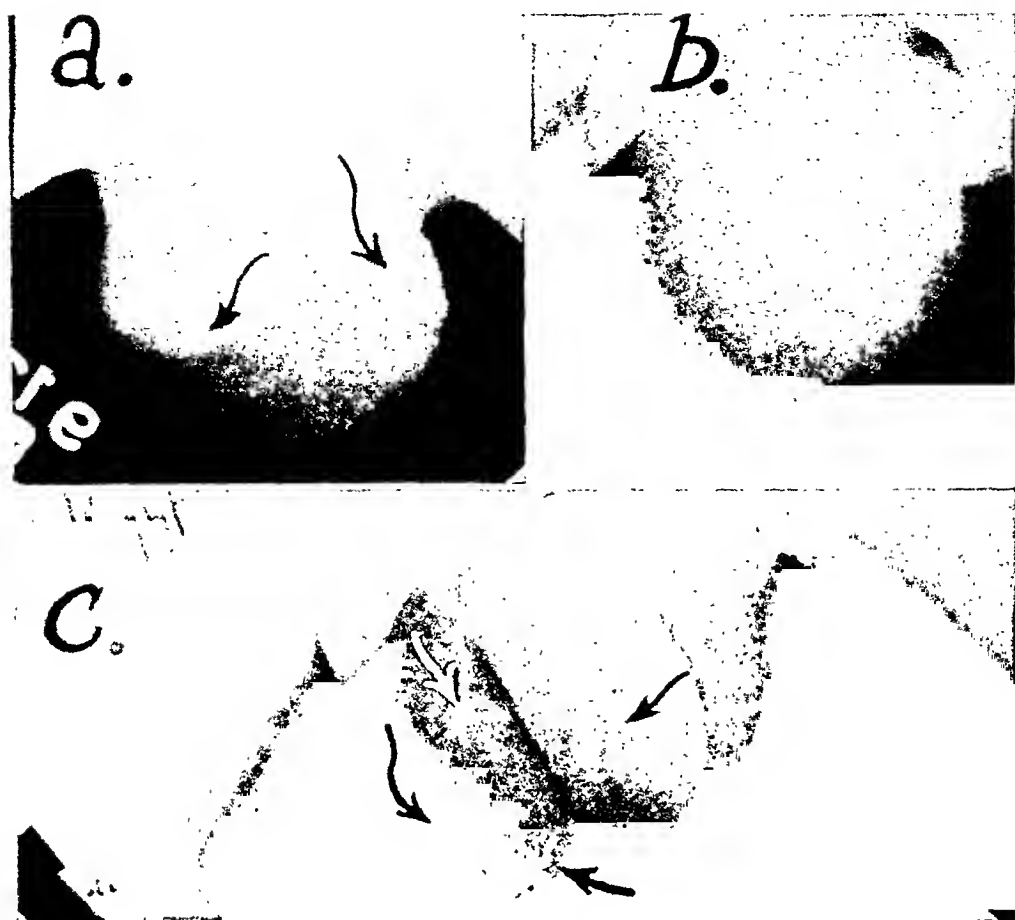


FIG. 21. Roentgenograms of the scrotum and its contents in three different cases. *a*, shows dense shadow indicated by arrow on the left, in a patient with a small tumor of the right testicle. The tumor gradually became smaller and finally could not be palpated, but the calcification persisted. Operation revealed an apparently normal testicle with a small calcium deposit free in the capsule surrounding the testicle. It was thought that the calcification had previously been within or attached to the testicle and had been extruded or detached. Arrow on the right indicates enlargement in left side of the scrotum due to varicocele. *b*, shows a large malignant tumor of the right testicle. No calcification is present. *c*, indicates extensive irregular calcification in the right side of the scrotum partially outlining a tumor. This calcification is outside the testicle and is considered to be due to an extensive tuberculous infection of the epididymis. This has not been proved since operation in this case was not considered advisable.

20B is a roentgenogram made in the lateral projection. The kidney is rotated, the pelvis being displaced anteriorly and somewhat cephalad. There is some anterior displacement of the proximal part of the ureter. The differential diagnosis rested between a very large solitary cyst or a primary malignant tumor involving the lower pole of the kidney. There was no history of bleeding, but because of the patient's age it was considered that the changes were at least three to one in favor of a malignant tumor. At operation June 1, 1944, a very large inoperable tumor was found involving the entire lower pole of the kidney. Microscopic section showed a necrotic adenocarcinoma. The patient was referred for deep roentgen therapy.

#### TESTICULAR TUMORS

The roentgen examination of the scrotum and its contents is of interest and in some cases of diagnostic importance in the examination of patients with obscure lesions of the scrotal contents (Fig. 21). Calcification may be evidence of an adult type of teratoma as opposed to an embryonal type of tumor such as seminoma. Calcification, however, may be the result of a tuberculous infection of the epididymis as was the case in one of our patients. This lesion could easily have been mistakenly diagnosed a malignant teratoma.



FIG. 22. Case IX. Malignant testicular tumor with metastases. Roentgenograms show metastatic lesions in posterior part of right hemithorax. Major involvement apparently in apex of lower lobe.

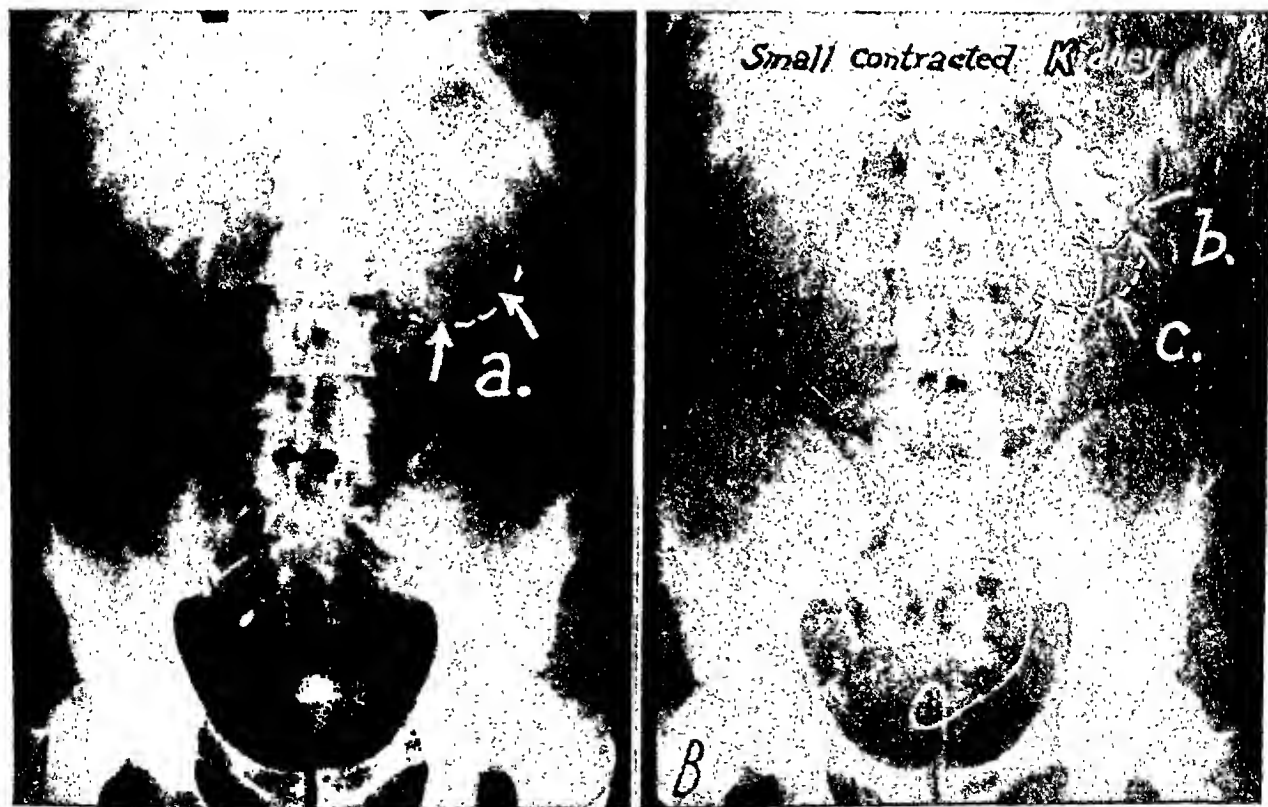


FIG. 23. Case IX. Malignant testicular tumor with metastases. A shows large tumor outlined at *a*. This illustration is part of an intravenous examination. The function and drainage on the right were normal. There was no evidence of any excretion on the left. B shows the lower pole outline of a small contracted kidney at *b* and the lower margin of a metastatic tumor at *c*. The ureter is displaced laterally and there is both horizontal and vertical rotation of this kidney.



FIG. 24. Case IX. Malignant testicular tumor with metastases. Marked posterior displacement of proximal portion of ureter by metastatic tumor shown in lateral projection at *a*.

Skeletal and abdominal visceral metastases are rare in testicular tumors. Metastases to the chest, either lymphogenous or hematogenous in origin are relatively common and are best demonstrated in conventional chest roentgenograms, a lateral projection always being a part of this examination (Fig. 22). The most common site of metastasis is in the region of the renal pedicle

**CASE IX.** This twenty-seven year old white corporal developed swelling in the left testicle in the fall of 1939. A left orchidectomy was done in April, 1940, and heavy deep radiation therapy was given postoperatively. Recovery was uneventful.

The patient was well until July, 1943, when he began to suffer from low back pain and respiratory distress. Two months later hemoptysis developed. He entered Percy Jones General and Convalescent Hospital in April, 1944. The roentgen examination showed a very large dense lesion occupying the region of the apex

of the right lower lobe and an intravenous urogram revealed a non-functioning left kidney. Retrograde filling of the left side of the urinary tract showed posterior displacement of the proximal end of the left ureter and the adjacent portion of the left kidney pelvis. The kidney was somewhat atrophic in appearance. A large spherical mass was shown lying immediately anterior to the displaced ureter and kidney pelvis. The patient was given radiation therapy. His general condition remains satisfactory although there has been relatively little change in the extensive metastatic lesions thus far.

The metastatic chest lesion is shown in Figure 22. The urinary tract findings by intravenous examination are shown in Figure

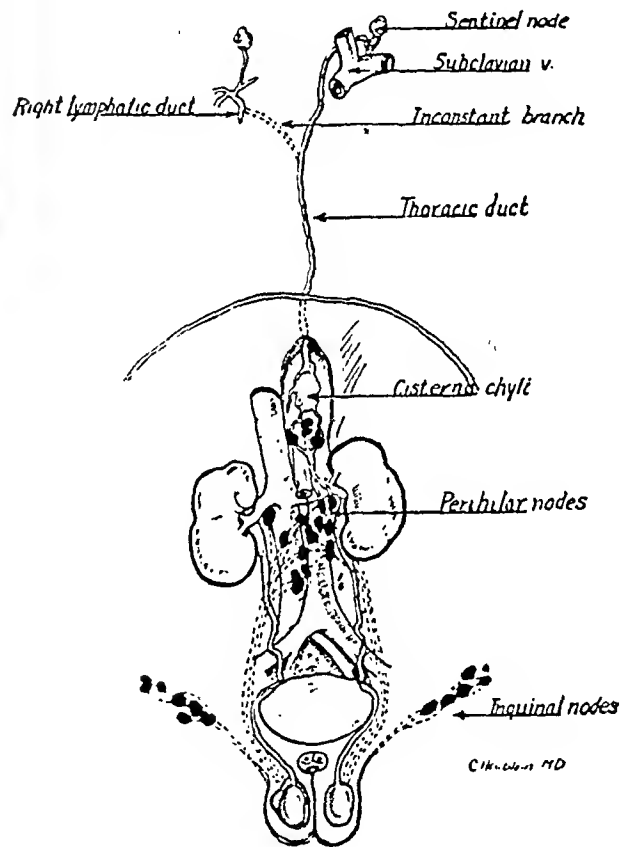


FIG. 25. Drawing by one of us (G.W.H.) showing lymphatic pathways extending proximally from the testicles to the peri-aortic lymph nodes, demonstrating the tendency to cross from right to left at the level of the renal pedicles and extending cephalad by way of the thoracic duct to the sentinel lymph node in the left supraclavicular space. The lymphatic pathways draining the skin of the scrotum are shown leading to the inguinal nodes. These are usually involved only late in testicular neoplasm.



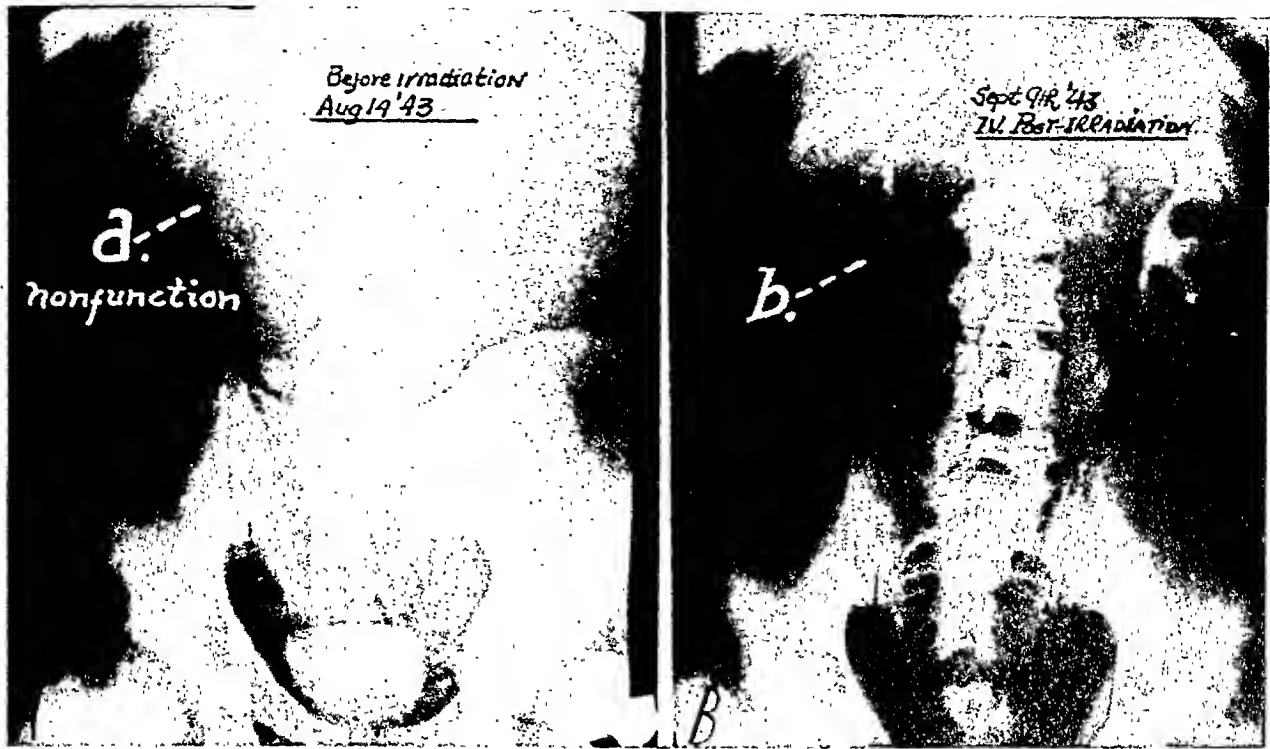


FIG. 26. Testicular neoplasm with metastases. *A* shows non-functioning right kidney at *a*. Function on left is satisfactory, but kidney is markedly displaced laterally. *B* shows return of function in right kidney. Displacement of left kidney is still marked, but somewhat less so than before. Case is to be reported in detail elsewhere.

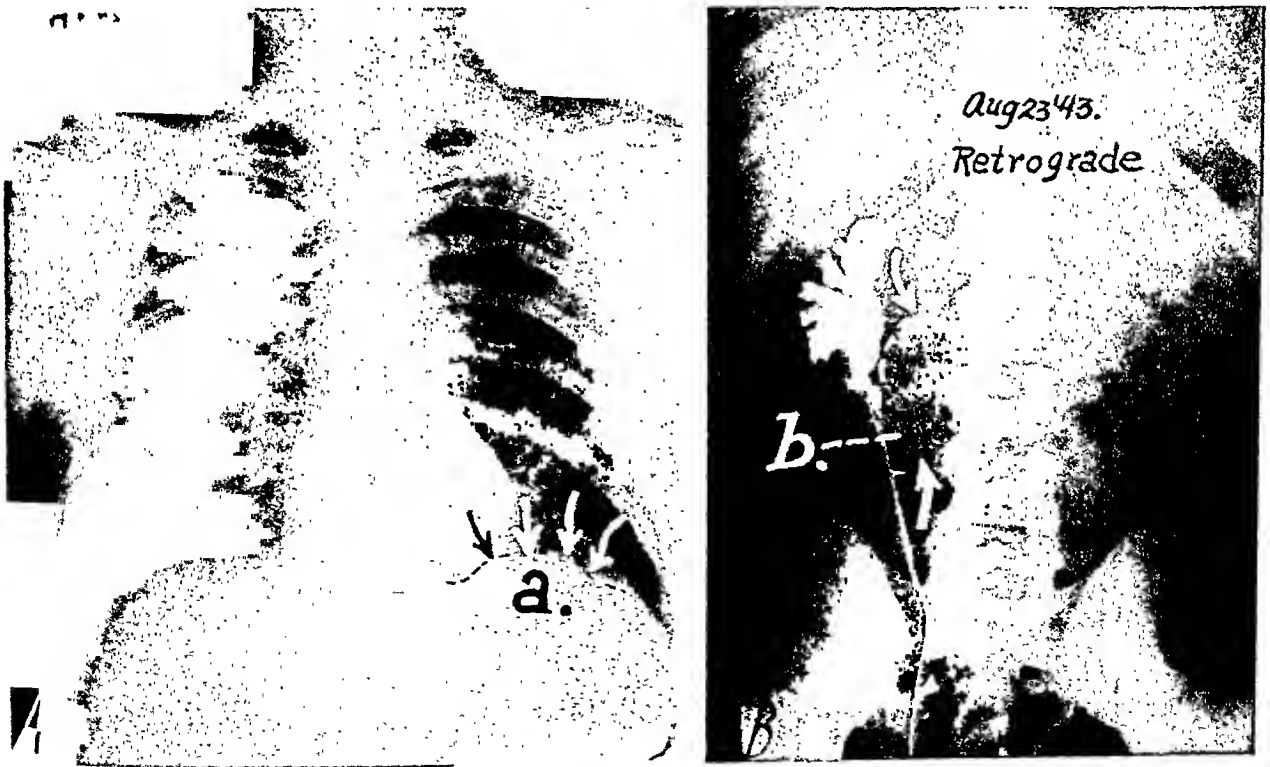


FIG. 27. Testicular neoplasm in same patient shown in Figure 26. *A* shows metastatic lesion at *a*. This disappeared promptly following radiation therapy. *B* shows retrograde filling of upper collecting system on the right at the time when no function could be demonstrated during the intravenous examination. The kidney and proximal part of the ureter are displaced laterally. A large metastatic tumor is outlined at *b*.

23*A*. The excretion in the right side of the tract is shown to be normal and the structures are well outlined. There is no evidence of any contrast material on the left and at *a* is shown a very large tumor which lies near the left renal pedicle. In Figure 23*B* retrograde filling of the involved upper collecting system is shown. Roentgenoscopic guidance was utilized. The shadow of the lower pole of the kidney is outlined at *b* and the lower margin of the tumor is outlined at *c*. The kidney appears somewhat contracted. The proximal portion of the ureter

neoplasm, "with the crossing from right to left of these lymphatic channels and with the tendency to massive growths at the level of the renal pedicle" (Randall) (Fig. 25). In other words, although a right or left testicular tumor may show predominantly unilateral metastases in the corresponding side of the abdomen, nevertheless right-sided tumors not infrequently involve the region of the left renal pedicle as is demonstrated in Figures 26 and 27.



FIG. 28. Case x. Testicular tumor with metastases. *A*, intravenous urogram showing normal function and drainage. What suggested lateral displacement of the left ureter by a metastatic mass is shown at *a*. *B*, lateral retrograde urogram made shortly after *A*. The kidney pelvis and ureter appear to be essentially normal in position.

is seen to be displaced laterally quite markedly. In Figure 24 the proximal part of the ureter is deviated posteriorly at *a*. The proximal part of the kidney pelvis is also displaced.

In a previous paragraph we have called attention to the work of Randall who has stated that "intravenous urography is a valuable asset in determining the prognosis in cases of metastases from testicular tumor." Both Randall,<sup>7</sup> and Chamberlin and Jamison,<sup>8</sup> demonstrate conclusively the importance of finding unilateral anuria in patients with this disease. One should recall the route of lymphatic spread of testicular

Our experience with testicular lesions during the last two years indicates that the above facts have not always been fully recognized. We believe very definitely that *intravenous urography at proper intervals coupled with frequent chest examinations affords the best possible method of following the progress of these patients* (Fig. 28, 29 and 30). The information obtained from good intravenous urography, with retrograde examination when necessary, often will determine when roentgen therapy should be terminated, or conversely, be energetically pursued to the limit of skin

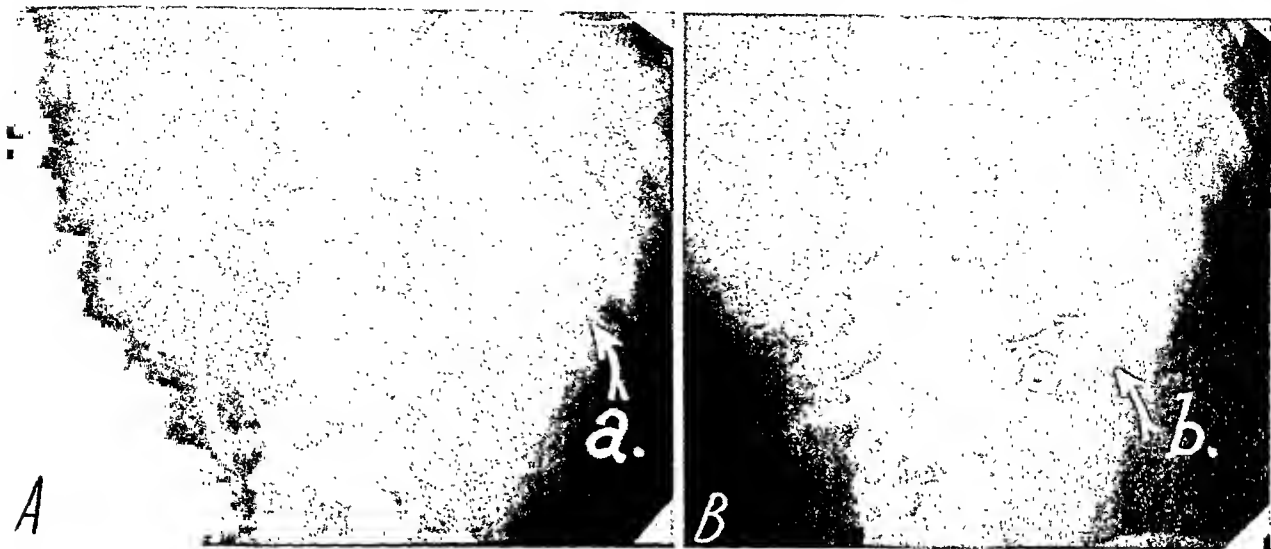


FIG. 29. Case x. Testicular tumor with metastases. *A*, fifteen minute intravenous urogram. Excretion and draining on right are normal. Dense left kidney shadow shown at *a* with only a suggestion of beginning filling of dilated minor calices. *B*, sixty minute urogram. Upper collecting system on left is now quite well shown. The ureter is markedly displaced, indicated at *c*, and apparently partially obstructed at *b*. This examination was made approximately two months following the one shown in Figure 28. In that figure early metastases are only suggested while the diagnosis is obvious at the later examination.



FIG. 30. Case x. Testicular tumor with metastases. Retrograde examination made one month after the intravenous examination shown in Figure 29. Displacement of ureter well shown at *a*. The lateral urogram indicated at *b* shows only very slight posterior displacement of the proximal part of the ureter.

tolerance. A falling urinary prolan affords the roentgenologist little comfort in the face of symptoms of persistent backache and positive urinary tract signs such as ob-

structive uropathy or homolateral anuria. By the same token, a temporary elevation of urinary prolan may be of no importance<sup>2</sup> when found in those whose general condi-

tion is excellent, whose subsequent course indicates apparent freedom from metastatic disease and in whom the urogram shows practically normal findings. Nash and Leddy<sup>6</sup> state: "Hormonal analyses are at best unreliable as far as the diagnosis of seminoma of the testis is concerned."

**CASE X.** This white soldier, aged twenty-one, was admitted to Percy Jones General and Convalescent Hospital in June, 1944. He gave a history of noting a mass in the left testicular area in September, 1943. This mass increased in size and in April, 1944, an orchidectomy was done at an overseas installation. The tumor was said to be a teratoma.

Upon admission a tumor was again found in the left scrotum. Chest examination showed nodular masses in the lung fields characteristic of metastases. An intravenous examination of the urinary tract on June 10, 1944, showed normal excretion. There was questionable slight lateral displacement of the proximal part of the left ureter indicated at *a* in Figure 28*A*. A lateral urogram made at this time (Fig. 28*B*) revealed nothing definitely abnormal. It was thought that there might well be early metastases displacing the proximal part of the left ureter. The patient was given radiation therapy to the chest, the mass in the left side of the scrotum and to the lymphatic pathways draining the scrotal area. The metastatic lesions in the chest regressed promptly and disappeared. The scrotal mass became much smaller. On August 18 the tumor in the left side of the scrotum was removed. A recurrent embryonal carcinoma was found. Extensive necrosis was present, evidently resulting from irradiation, but there were a few viable tumor cells.

A second intravenous examination of the urinary tract was done September 9, 1944. At this time excretion was found to be markedly delayed on the left, the function being quite markedly impaired. The findings are shown in Figure 29. In Figure 29*A* the right pelvis and ureter are well outlined, but there is only a suggestion of opaque material in the minor calices of the left kidney. This renal shadow is very dense and is indicated at *a*. Figure 29*B* shows a urogram made sixty minutes after administration of the diodrast. Marked displacement of the ureter is shown at *c* and an apparent partial obstruction of the ureter indicated at *b*. Retrograde examination (Fig. 30) confirms the

above findings, but fails to show any gross abnormality in the lateral projection (Fig. 30*b*).

Our urographic data\* suggest that lateral displacement of the renal shadow and proximal ureter is a frequent, if not pathognomonic, finding in neoplasm of the testis (Fig. 31). Occasionally a secondarily contracted kidney is observed. Huge mass lesions may be present with negligible subjective complaints on the part of the patient (Fig. 32). Lateral urograms usually reveal slight posterior renal or ureteral displacement although in one recent instance marked anterior displacement of the kidney shadow and ureter was demonstrated, thus producing an appearance easily mistaken for a postperitoneal sarcoma or indurated perinephritic abscess.

**CASE XI.** This twenty-nine year old corporal first noted a soft tumor in the left testicular area in December, 1943. He was examined and clear fluid aspirated. The testicle continued to increase in size and on March 25, 1944, an orchidectomy was done in an overseas hospital and a teratoma, the type of which was not reported, was found. Patient admitted to our hospital for radiation therapy May 8, 1944.

Physical examination showed a large firm tumor in the left upper quadrant of the abdomen. Intravenous urography demonstrated normal function on the right and markedly impaired function on the left. A retrograde urogram was done under roentgenoscopic guidance and the findings are shown in Figure 31. There is marked deformity of the proximal part of the left ureter and dilatation of the minor calices at *a*. The pelvis and calices are displaced posteriorly at *b*.

Re-examination following deep radiation therapy showed improvement in the function on the left and less distortion of the ureter. The patient's condition was excellent when discharged to a Veteran's Facility for further care, but the ultimate prognosis is grave.

**CASE XII.** This white soldier, aged twenty-six, first noted a mass in the left testicle in June, 1943. Slow painless enlargement took place. In June, 1944, he experienced severe pain

\* Based on the observation of 65 cases of testicular tumor at Percy Jones General and Convalescent Hospital during the past two years.



FIG. 31. Case XI. Testicular tumor with metastases. Retrograde examination showing marked distortion of proximal portion of ureter and dilatation of minor calices. Kidney pelvis and proximal ureter displaced laterally and posteriorly. Margin of kidney shadow is indicated at *a* and posterior displacement at *b*.

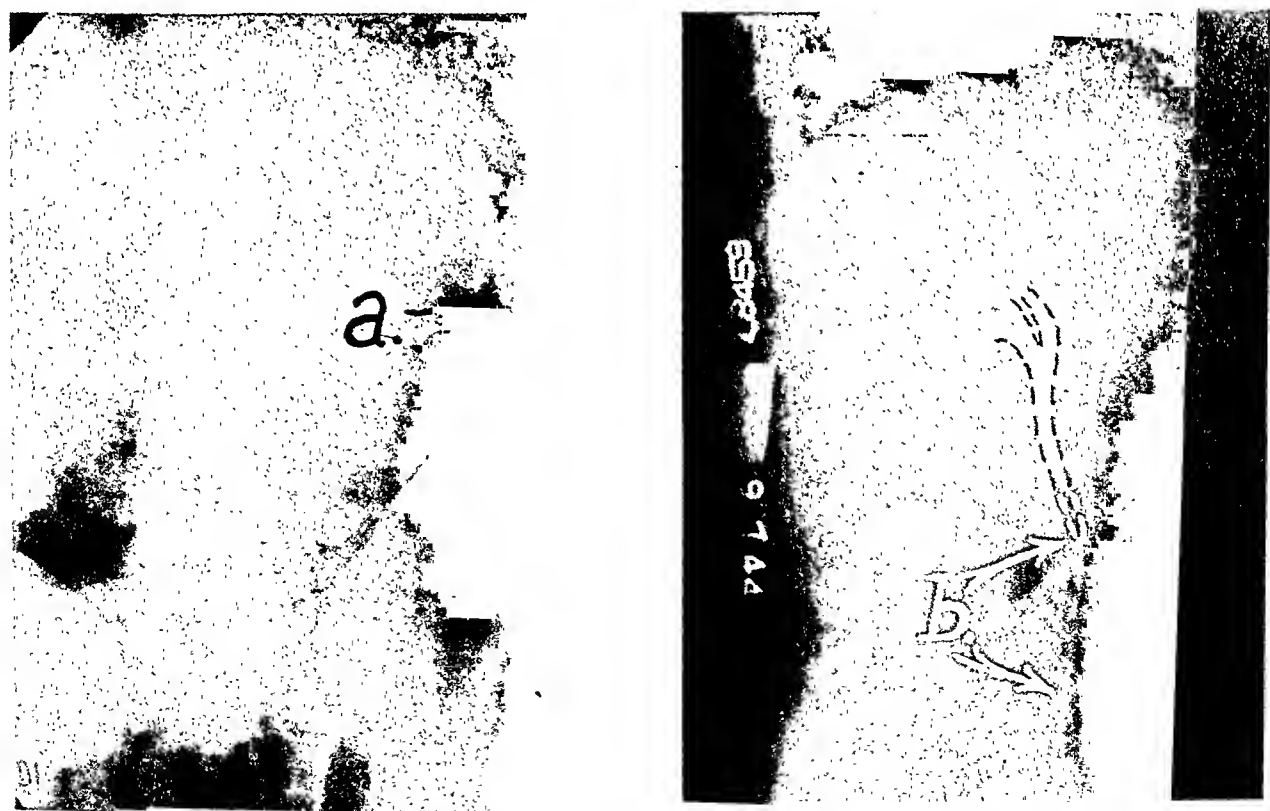


FIG. 32. Case XII. Testicular tumor with metastases. Urograms show marked lateral and anterior displacement of left kidney pelvis and ureter indicated at points *a* and *b* due to huge metastatic deposits.

in the left side of the scrotum and was immediately hospitalized. Physical examination revealed a large hard tumor in his left upper abdomen which extended downward below the level of the umbilicus. The mass extended medially beyond the midline and was hard, non-tender and nodular.

The findings at intravenous urography revealed impairment in the renal function on the left. The kidney was markedly rotated lateral-

operative teratoma of the left testis. He was well until January, 1944, when, while serving overseas, he fell astride a log. He noted severe pain in the left side of the scrotum at this time and shortly afterward palpated a small hard nodule in the testis. He had no further symptoms until June, 1944, when the pain returned and a very definite nodule was found in the left testicle. An orchidectomy was done and a teratoma of the testicle was reported.



FIG. 33. Case XIII. Teratoma of left testis with questionable metastases. Fifteen minute urograms made during an intravenous examination. Partial obstruction of the distal portion of the right ureter is shown near the level of the ischial spine. The ureter is displaced medially and posteriorly above this level. There is a suggestion of what may be lateral displacement of the ureter at the level of the third lumbar vertebra. *B*, unusually satisfactory lateral projection. Visualization of this type is possible only when there is interference to emptying of the distal part of the ureter.

ward and displaced laterward as well. A very large tumor mass was faintly shown lying medial to the displaced upper collecting system.

A retrograde urogram was also made and the findings are shown in Figure 32. The marked displacement of the kidney and ureter and the evidence of rotation is well shown at *a*. Anterior displacement of the ureter, most marked in the lower lumbar region, is shown at *b*.

The patient is being given deep radiation therapy. It remains to be seen what the final outcome of this case will be.

CASE XIII. This white soldier, aged twenty-three, was admitted with a diagnosis of post-

The patient was returned to the United States for further observation and care and was admitted to this hospital for deep radiation therapy. Upon admission he seemed to be clinically well. An excretory urogram was made and our findings at the fifteen minute period are shown in Figure 33. The function was normal. There was evidence of a partial obstruction of the right ureter near the level of the ischial spine and a suggestion of what might be a tumor could be seen medial to the area of narrowing in the ureter. There was also a suggestion of lateral displacement of the ureter near the level of the third lumbar vertebra. The ureter lay quite far posteriorly. Whether these changes



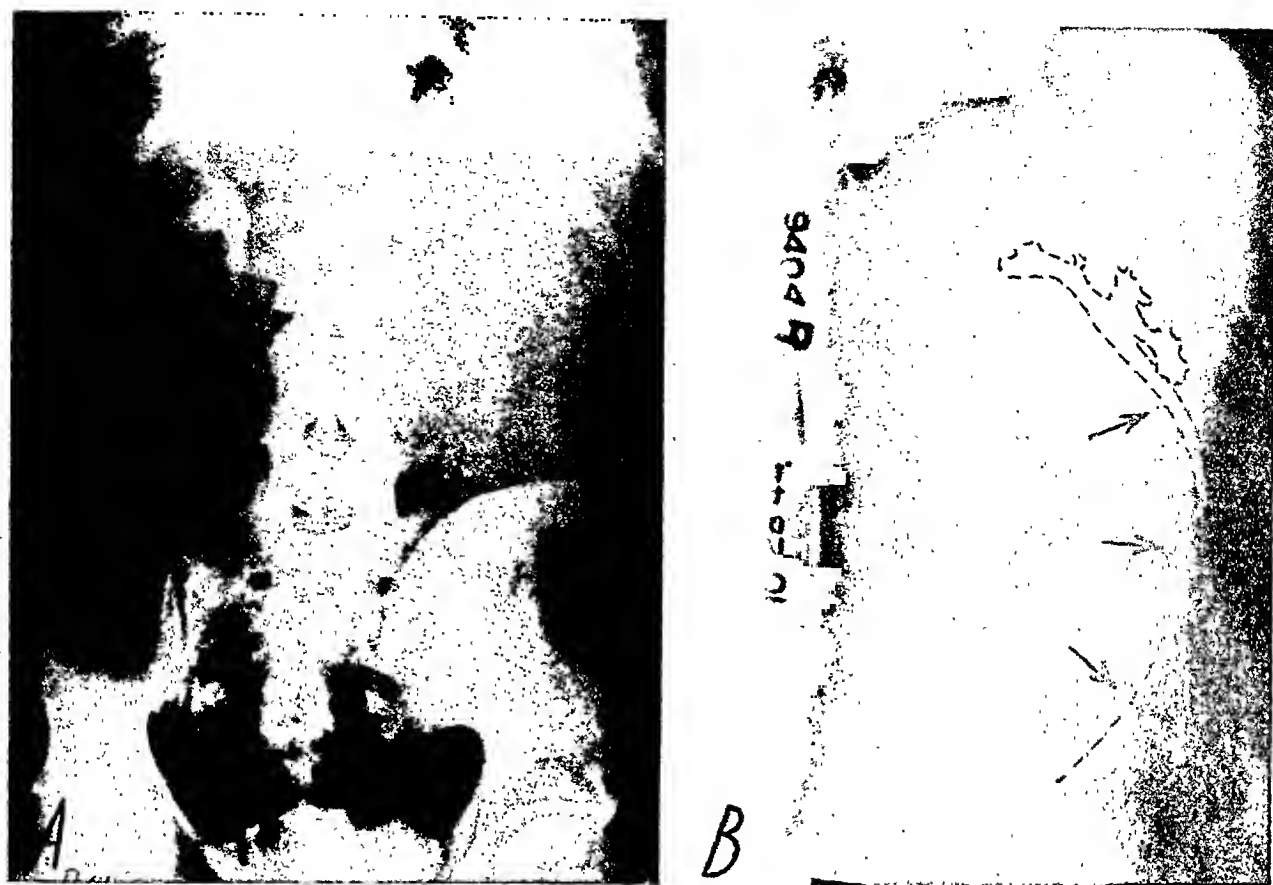


FIG. 34. Case XIV. *A*, intravenous urogram shows a large tumor mass filling the left side of the abdomen. The kidney was still functioning, but was displaced upward and rotated outward. The structures on the right were normal. *B*, left lateral retrograde urogram, showing marked anterior displacement of the distal two-thirds of the kidney and of the greater part of the ureter by a huge metastatic mass.

were due to masses displacing the ureter or a normal variation could not be said with certainty, but it seemed probable that metastases were present.

A careful physical examination failed to reveal any palpable masses in the abdomen. The patient was having no urinary symptoms at this time. Radiation therapy was instituted. A follow-up examination has not been done as yet and our findings can be taken only as suggestive of metastases. It is not usual for a left testicular tumor to metastasize to the right although this may occasionally occur.

The above findings are in sharp contrast to our experience with abdominal Hodgkin's disease, where the pathological changes have often been displacement or obstruction of the ureter in its distal two-thirds (Fig. 38, 39 and 40).

In our experience the intravenous urogram has been of marked value in the demonstration of metastases in the area of the urinary tract and is the method of

choice in the primary study of these cases. It is a reliable index of function and of decided aid in prognosis. Early changes are manifested by displacement and/or rotation of the kidney or proximal portion of the ureter on the affected side. Displacement of the proximal part of the ureter is perhaps even a more frequent finding than renal displacement. Marked impairment or complete absence of renal function on the affected side is not infrequently encountered in advanced cases and is usually of serious import. The retrograde examination assumes major importance in a more detailed study and particularly in borderline cases. Here the lateral projection often yields information not demonstrable by other methods.

The retrograde filling of the upper collecting system of a kidney which at the intravenous examination has shown no evidence of function is of interest, often show-



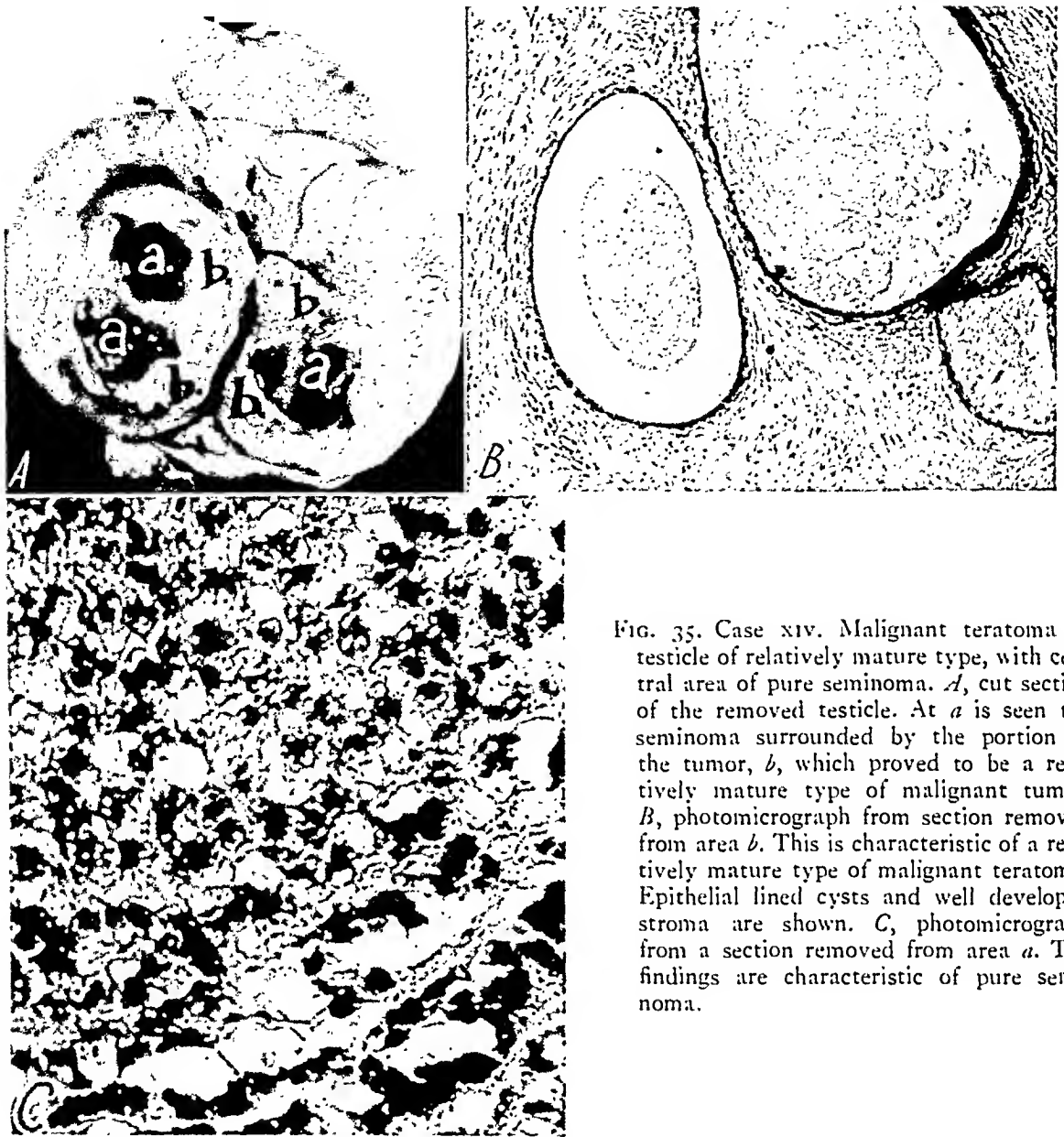


FIG. 35. Case XIV. Malignant teratoma of testis of relatively mature type, with central area of pure seminoma. *A*, cut section of the removed testis. At *a* is seen the seminoma surrounded by the portion of the tumor, *b*, which proved to be a relatively mature type of malignant tumor. *B*, photomicrograph from section removed from area *b*. This is characteristic of a relatively mature type of malignant teratoma. Epithelial lined cysts and well developed stroma are shown. *C*, photomicrograph from a section removed from area *a*. The findings are characteristic of pure seminoma.

ing the system to be essentially normal in appearance. This is in keeping with the prompt return of function that so frequently follows adequate radiation therapy (Fig. 26 and 27). The mechanism of the disturbed function in these cases is not entirely understood at the present time.

Attention is again directed to the fact that the intravenous examination is of great aid in prognosis and in estimating the results of radiation therapy. For example, the return of function in a previously non-functioning kidney following irradiation

may indicate a good therapeutic result. On the other hand, when a previously functioning kidney ceases to function during or following radiation therapy the prognosis is grave (Fig. 28, 29 and 30).

As is generally recognized large metastatic lesions in the region of the renal pedicles cause marked displacement and at times compression of the adjacent parts of the gastrointestinal tract. Gastrointestinal examinations and frequent re-examinations, including those of the small bowel, are done when indicated. The importance of this is

illustrated by Case xiv. Not only were the stomach and proximal small bowel markedly displaced, but a high degree of obstruction was found near the junction of the duodenum with the jejunum. The history and findings in this case follow.

CASE XIV. The patient developed pain in left inguinal area in June, 1944. This became increasingly severe and radiated down the lat-

of the left renal pedicle. Because of the location, primary tumor of the testicle was considered a distinct possibility and physical examination disclosed a small palpable left testicular mass. An orchidectomy was done. The findings, as stated in the pathological report, were a teratoma of the testis exhibiting a focus of embryonal carcinoma. They were of interest because of the demonstration of seminoma cells lying within a mature teratoma of mixed type.

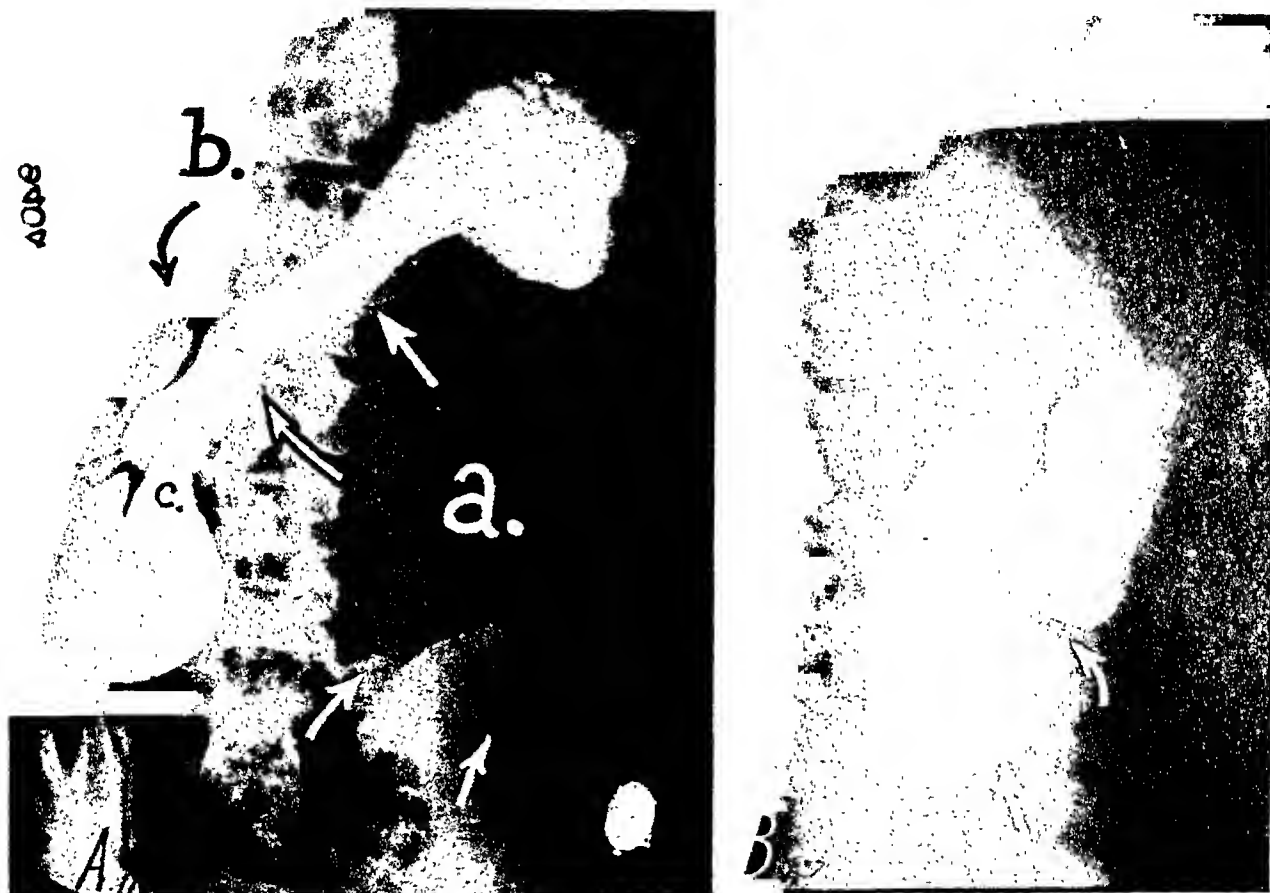


FIG. 36. Case xiv. Roentgenograms from a gastrointestinal examination showing marked cephalad and anterior displacement of the stomach with narrowing of the lumen. In *A*, a high degree of obstruction is shown in the region of the junction of the duodenum with the jejunum. The duodenum is markedly dilated. *a* and adjacent arrows indicate area of deformity in stomach; *b*, duodenal cap; *c*, region of obstruction. Lower arrows on left indicate lower margin of metastatic tumor causing the obstruction. *B*, lateral roentgenogram. Markedly dilated duodenum is indicated by arrows.

eral aspect of the thigh. The first hospital admission was in September, 1944, at which time a large firm tumor mass was found in the left upper quadrant. The patient was transferred to Percy Jones General and Convalescent Hospital. An examination of the urinary tract (Fig. 34) showed the kidney to be displaced to the left, anteriorly and cephalad as was the proximal two-thirds of the ureter. It was obvious that the tumor mass was retroperitoneal in location, the major portion being in the region

This tumor contained not only urinary bladder and pelvic epithelium, but also embryonal neuroblasts or cells having the appearance of retinoblasts (Fig. 35). The prolan was less than 300 mouse units.

The patient developed rather severe nausea and vomiting while being given radiation therapy. It was at first thought that the symptoms were due to the irradiation, but they persisted and a gastrointestinal examination showed an almost complete obstruction in the region of

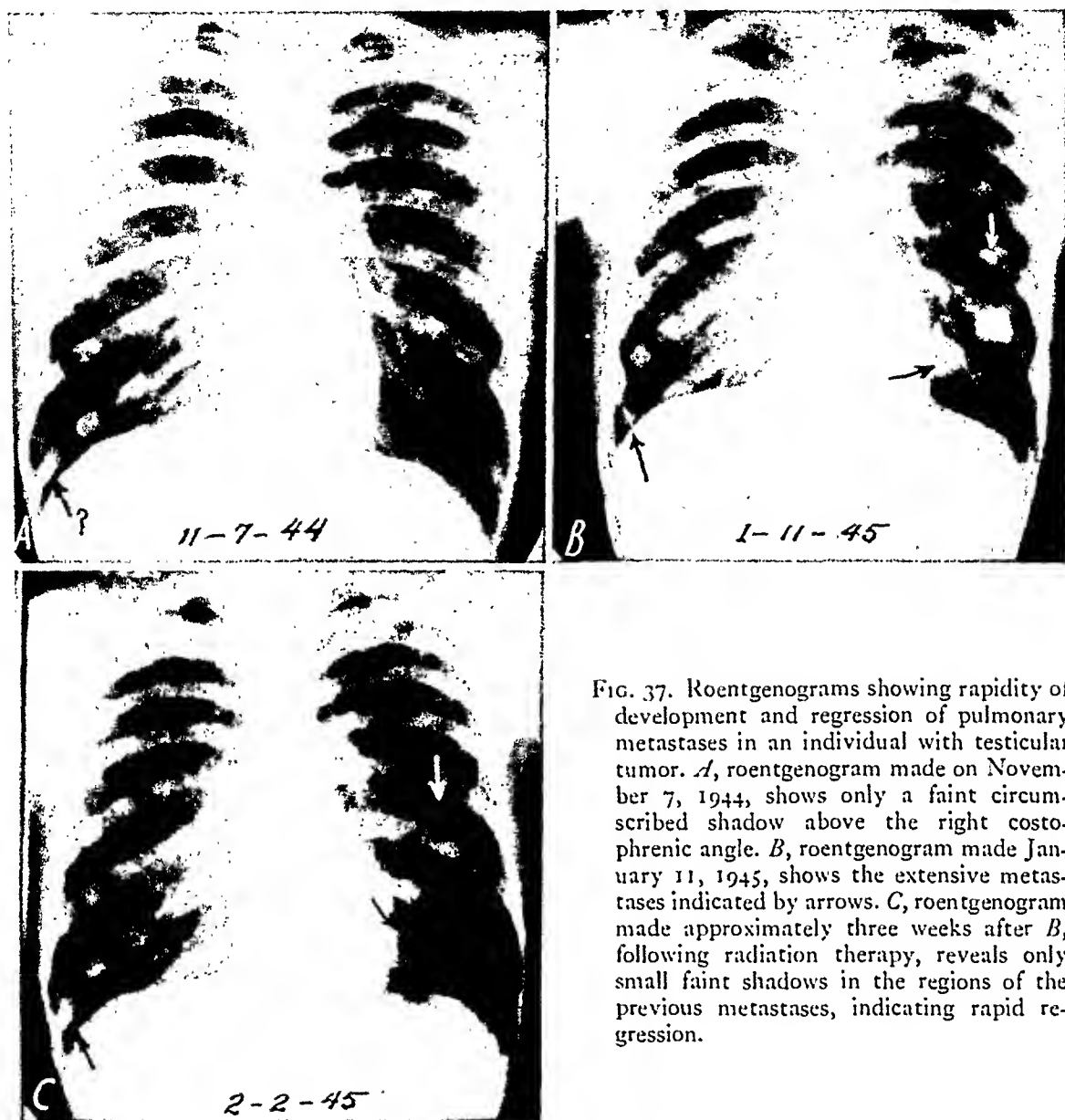


FIG. 37. Roentgenograms showing rapidity of development and regression of pulmonary metastases in an individual with testicular tumor. *A*, roentgenogram made on November 7, 1944, shows only a faint circumscribed shadow above the right costophrenic angle. *B*, roentgenogram made January 11, 1945, shows the extensive metastases indicated by arrows. *C*, roentgenogram made approximately three weeks after *B*, following radiation therapy, reveals only small faint shadows in the regions of the previous metastases, indicating rapid regression.

the duodenojejunal junction. The stomach was displaced anteriorly and cephalad. The findings are shown in Figure 36.

Operation revealed a very large retroperitoneal mass obstructing the small bowel in the region of the ligament of Treitz. An anterior gastroenterostomy and enteroenterostomy were done. Complete atelectasis of the left lung developed twenty-four hours postoperatively, but cleared promptly following bronchoscopy and aspiration. The postoperative course was otherwise uneventful.

Importance of repeated chest examinations deserves special emphasis. Metastases

may appear and grow with great rapidity. Likewise they may regress promptly when suitable therapy is instituted. The above is well illustrated in Figure 37.

It is not within the scope of this paper to report in detail the findings in all the cases of testicular tumor that have been under our care during the past eighteen months. We are reporting briefly only a few representative cases in which the roentgen findings have been of importance in diagnosis, prognosis and in determining the plan of treatment.

THE LYMPHOMAS, INCLUDING  
HODGKIN'S DISEASE, AND  
THE LEUKEMIAS

In Percy Jones General and Convalescent Hospital, as a part of the general examination in all of the above conditions, the urinary tract is routinely surveyed. From the roentgen viewpoint, intravenous urography is done first and this is followed by a retrograde investigation when indicated. In the latter, again filling under roentgenoscopic guidance and lateral exposures have proved to be of value.

The findings in these cases differ only as a result of the different manifestations of these diseases. Lymphosarcomas can be demonstrated only if structures adjacent to some part of the urinary tract are involved and pressure defects or displacement result, a not infrequent occurrence.

In Hodgkin's disease one may see lesions that cause pressure defects, displacement and at times actual obstruction of various parts of the urinary tract. In our experience, the distal portions of the ureters have been involved instead of the proximal ureters and kidney pelves as has been the case in metastases from testicular tumors.

**CASE XV.** This twenty-nine year old sergeant first noted severe pain in the right lower quadrant radiating down the leg in October, 1943. Two months later a firm mass appeared in the base of the neck and the patient was returned to the continental limits of the United States for further observation and treatment, a diagnosis of Hodgkin's disease having been made.

Physical examination upon admission to Percy Jones General and Convalescent Hospital in February, 1944, showed a large irregular tumor in the left supraclavicular area. A second mass was palpable in the right lower quadrant. There was an autotomy of the right leg. Roentgenograms showed marked enlargement of the mediastinal lymph nodes near the arch of the aorta. An intravenous urogram showed obstruction of the right ureter near the junction of the proximal with the middle third. The obstruction corresponded to the upper margin of the palpable mass.

The chest findings are shown in Figure 38. In

Figure 39 the obstruction of the right ureter is shown, indicated at *a*. This was a delayed urogram, relatively little of the opaque material remaining in the left side of the tract at this time. Figure 39B shows markedly improved function and drainage seventy-two days later following irradiation. There was no evidence of obstruction of the ureter at this time. Improve-



FIG. 38. Case xv. Hodgkin's disease. Roentgenogram of the chest showing left superior mediastinal tumor.

ment was only temporary, however, and due to the widespread involvement the patient's course was rapidly retrogressive until death.

**CASE XVI.** This private, aged twenty-eight, was well until August, 1943, when he developed a cough, did not feel well and began to lose weight. This was associated with a high fever. Two weeks later he noted a swelling in the right groin which increased in size quite rapidly. A biopsy of the enlarged glands in the neck was done overseas and a diagnosis of Hodgkin's disease made. He was given radiation therapy overseas, with regression of the enlarged lymph nodes and improvement in his general condition. He was admitted to this hospital for further radiation therapy.

An intravenous examination of the urinary tract showed marked medial displacement of the distal portion of the right ureter and ante-

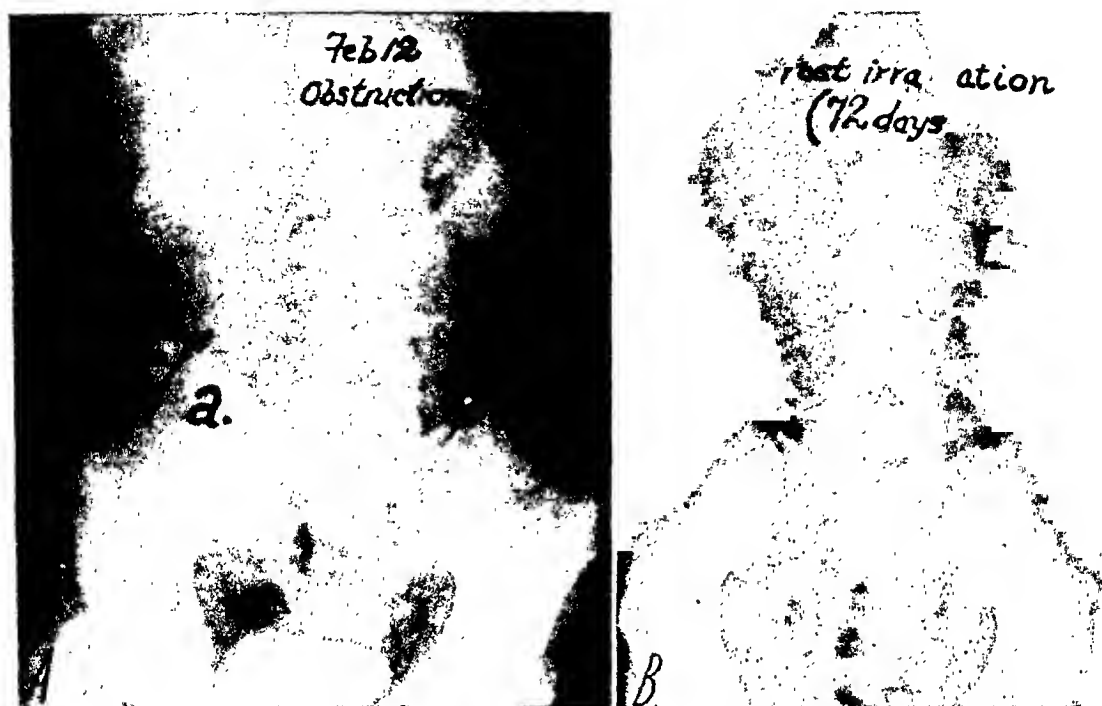


FIG. 39. Case xv. Hodgkin's disease. *A*, thirty minute intravenous urogram. It shows a rather high degree of obstruction at *a*. The excretion and drainage on the left were normal. *B* shows normal excretion and drainage on both sides seventy-two days later following irradiation.



FIG. 42. Case xvi. Hodgkin's disease. Medial and anterior displacement of the ureter indicated at points *a* and *b*. There was no clinical evidence of metastatic disease within the abdomen at the time of this examination and no palpable mass had been detected during physical examination.

rior displacement of the distal two-thirds of the ureter as well. A large tumor could be palpated in the region of the displaced ureter. The findings at retrograde examination of the right side of the urinary tract are shown in Figure 40. The area of medial displacement of the ureter is shown at *a* and the area of anterior displacement at *b*.

The patient has been given heavy radiation therapy to many fields. The response to treatment was satisfactory and at the time of separa-

such invasion because of changes seen in urograms characterized by enlargement of the kidney shadow and enlargement and/or deformity of the pelvis and calices. Our opinions regarding leukemic invasion of the kidney parenchyma have not been confirmed at autopsy in all cases, however. It would seem that congestive changes may play an important rôle in the apparent renal enlargement seen during intravenous



FIG. 41. Case xvii. Chronic myelogenous leukemia. *A*, twenty minute intravenous urogram. The left kidney shadow shown at *b* is obviously markedly enlarged and is displaced downward and rotated. There was some enlargement of the kidney pelvis and calices on the right. The lower and right lateral margins of a greatly enlarged spleen are shown at points *a*. *B*, fifteen minute intravenous urogram made four months after *A*. The lower margin of the spleen outlined at *c* is now near the costal margin. The kidneys are smaller than before. The rotation on the left has decreased. Some stasis is probably present.

tion from service the patient was in excellent general condition.

In the leukemias, the left kidney may be displaced downward by a markedly enlarged spleen and such displacement may result in interference with drainage (Fig. 41). The frequency with which leukemic invasion of the kidney parenchyma takes place is generally known. Kirshbaum and Preuss<sup>3</sup> report 63 per cent of kidneys involved by all forms of leukemia at necropsy. One may suspect the presence of

urography. Such an appearance may simulate changes due to actual leukemic invasion of the kidney parenchyma.

CASE xvii. A male, aged twenty-two, was admitted with a history of weakness and shortness of breath, loss of appetite and a feeling of fullness in the left upper abdomen. The symptoms were first noted in December, 1943, when on maneuvers. Weakness, loss of appetite and night sweats became marked while on duty overseas.

Physical examination showed a large firm mass in the left upper quadrant extending down

to the level of the iliac crest. It was obviously a very markedly enlarged spleen.

Blood examination revealed 3,050,000 red cells and 587,000 white cells. The differential count at this time showed 2 per cent myeloblasts, 13 per cent promyelocytes, 18 per cent neutrophilic myelocytes, 16 per cent metamyelocytes, 24 per cent stabs, 12 per cent segmented forms, 5 per cent eosinophiles, 3 per cent eosinophilic myelocytes, 6 per cent basophilic myelocytes, 1 per cent mononuclear cells. The diagnosis of chronic myelocytic leukemia was obvious. Radiation therapy was given with progressive improvement, the blood findings returning to normal.

An intravenous examination of the urinary tract upon admission showed marked downward displacement of the left kidney due to a greatly enlarged spleen. The kidney was enlarged and the pelvis and calices dilated. The findings are shown in Figure 41, the border of the spleen being indicated at *a* and the enlarged and displaced left kidney at *b*. The change in the size of the spleen following radiation therapy and the improvement in the appearance and position of the left kidney are indicated at *c*.

#### COMMENT

1. The intravenous urogram is an important diagnostic aid in the study of urinary tract disease of many types.

2. It is an examination that requires careful supervision by one thoroughly familiar with the indications for its use, its limitations and the technical requirements of the examination.

3. The intravenous and retrograde methods of examination are not competitive, but are complementary.

4. Retrograde filling of the urinary tract under roentgenoscopic guidance should be resorted to more often than has been done heretofore.

5. Roentgenograms of the urinary tract made in the lateral projection are of de-

cided aid in diagnosis when indicated.

6. In individuals with testicular tumors, the earliest demonstrable metastases are frequently in the region of the renal pedicles. Intravenous urography is of primary importance in these cases not only in demonstration of metastases, but in prognosis and in the determination of the results of therapy as well.

7. Attention is directed to the fact that primary testicular tumors may be very small and remain so even when large metastatic masses are present elsewhere.

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# AEROSINUSITIS

## A CLINICO-ROENTGENOLOGICAL STUDY

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**A**MONG the problems peculiar to aviation medicine are otorhinological affections caused directly by the action of rapid changes of barometric pressure on aviators during flight and on personnel in altitude chambers. Such individuals may be transported rapidly from low to high barometric pressures or from high to low pressures. These changes are reflected more or less closely in the paranasal sinuses and in the middle ear, which are connected to the nose and nasopharynx by relatively narrow passageways. An equilibrium tends to be maintained thereby between atmospheric pressure in the environment and nares on the one hand, and in the paranasal sinuses and middle ear, on the other hand. Because their passageways are small and often display anatomical variations in size and shape, it is not surprising that such radical barometric changes may call forth unusual responses in these structures. Thus, blockage of the eustachian tube, leading to a relatively negative pressure in the middle ear, causes the well known syndrome of aero-otitis media with its attendant edema and transudation or hemorrhage.<sup>1,2</sup> This condition has recently been the subject of roentgenological investigation by Larkin.<sup>3</sup>

A search of the literature fails to reveal a clinico-roentgenological study of aerosinusitis, an entity which is very similar to aero-otitis media in its inception and course, and whose probable mechanism has been described by Campbell.<sup>3</sup> There has been no study of the gross or microscopic pathology of aerosinusitis as yet. Clinical and roentgenological evidence indicates, however, that mucosal edema, transudation and even hemorrhage may occur in a sinus whose ostium is apparently blocked suddenly by a mucous plug or redundant

mucosa, while the affected individual is descending from altitude, real or simulated. This disorder is by no means frequent during flight or chamber runs, but its occurrence and ensuing disability are sufficient to make it a subject of importance in aviation medicine.

### ANATOMICAL AND PHYSIOLOGICAL CONSIDERATIONS

The paranasal sinuses are outpouchings of the nasal portions of the respiratory tract and expand into air-containing recesses. They retain their connections to the nasal passages by ostia or ducts, which are usually small. These connections may be somewhat indirect, as in the often tortuous, narrow nasofrontal ducts. They are sometimes at a level well above the floors of the corresponding sinuses (notably the maxillary and posterior ethmoid sinuses) and thereby tend to impede drainage. Since the risk of blockage would seem to be greater in a duct or canal than in a simple ostium, it may be that the demonstration of aerosinusitis only in the frontal and maxillary sinuses is at least partly accounted for by the existence of the nasofrontal duct in the frontal sinus, and by the possible presence of a maxillary canal, rather than only an ostium, in many maxillary sinuses.<sup>3</sup> It is possible, of course, that involvement of the other paranasal sinuses by this disorder may occur and be unrecognized as yet.

Drainage of the accessory sinuses is normally dependent on gravity, on the ciliary activity of their mucosal membrane and on the continuity of the mucus of the nose and sinuses. They are lined by a delicate mucosa supplied by a rich network of capillaries and lymphatics, and so intimately

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applied to the bony walls<sup>6</sup> that the term "mucoperiosteum" is more descriptive. This intimate alliance of the mucoperiosteum and sinus walls, and the richness of the vascular bed, have important bearing on the symptoms and signs of aerosinusitis.

From the foregoing observations, several concepts may be developed:

1. The patency of the sinus ostium, duct or canal is essential to the free interchange of air between a sinus and the nasal passage. Obstruction to an ostium may therefore create a pressure imbalance between environment and sinus, with the intrasinus pressure negative in relation to the external atmospheric pressure.

2. Sudden development of increasing negative pressure in a sinus, sufficient to cause stretching and ballooning of the mucosa, would tend to traumatize its network of blood vessels and lymphatics and could conceivably lead to mucosal edema and hemorrhage.

3. The frontal sinuses, and those maxillary sinuses which may have canals rather than ostia, would be especially susceptible to blockage.

4. Under certain unfavorable conditions, nasal secretions may be forced into the accessory sinuses through patent ostia,<sup>3</sup> and if infected might in turn cause a catarrhal or purulent sinusitis. Particularly susceptible are sinuses already handicapped by disadvantageous location of their ostia and with residual mucosal damage from previous infection. Experimental evidence indicates that healthy sinuses are resistant to infection by aspiration. It should be noted at this time that ordinarily the atmospheric pressures in the nose and sinuses are equal or approximately equal,<sup>9</sup> but Proetz<sup>7</sup> and later Judd<sup>8</sup> showed that a time lag exists during equalization of changing intra- and extrasinus pressures. It seems likely that such a time lag may be prolonged as descent from high altitude proceeds uninterrupted, and the pressure differential between the sinuses and nasal passages may thereby be progressively increased. In turn,

the increasing pressure gradient might provide sufficient force to introduce nasal secretions into a sinus and set up a sinusitis if mucosal damage in the sinus already exists. This succession of events might also produce prodromal conditions conducive to the abrupt occurrence of aerosinusitis if sudden ostial blockage were superimposed.

#### COURSE

An aviator in flight, descending from high to lower altitude, enters regions of successive greater atmospheric pressure. The same progression occurs in the case of the individual "descending" in the altitude chamber. At higher altitudes, decreased atmospheric pressure exists in the environment, nasal passages and sinuses. Normal relationships must be maintained during descent by free ingress of air into the sinuses, in order to balance intrasinus pressure with that of the environment. However, an ostium may be completely occluded by impingement of a small flap of redundant nasal mucous membrane or a thick mucous plug, due to the pressure of the inflowing air and the pressure differential between the sinus cavity and nasal passage. The presence of swollen, edematous nasal mucosa may facilitate such occlusion, particularly if adjacent to or actually involving an ostium. With the ostium occluded and descent continuing, the pressure differential between the nasal passage and the affected sinus rapidly increases. An attempt to equalize this gradient is called forth and, with no immediate way of re-establishing patency of the ostium, the volume of the intrasinus cavity must be decreased in order to maintain normal pressure of the contained gas (Boyle's law). This decrease is effected by a marked swelling of the lining membrane. The mucosal swelling is attributed to edema, and may be accompanied by transudation or hemorrhage, sometimes with formation of a mucosal hematoma and bloody discharge later from the affected sinus.

If hemorrhage occurs, it must follow rup-

ture of some of the tiny vessels with which the sinus mucosa is abundantly supplied. Frank bleeding may then be caused by seepage from a hematoma, or damage to the continuity of the mucous membrane. The initial trauma to the blood vessels is apparently of the same origin as that which causes the edema of the mucosa: the partial intrasinus vacuum and the increasing pressure differential between the sinus and nasal passage. It may then be assumed that the difference between the trauma causing edema and that causing hemorrhage is one of degree, or that variations in resistance of the local blood vessels and lymphatics account for the different results. Thus, previous insult to the sinus mucosa (e.g., by infection) may leave its structures less resistant to such trauma. At any rate, the direct etiological factor appears to be the pressure gradient. Its effect might be termed "barometric trauma" to the sinus mucosa.

Granting the possibility of aspiration of the infected nasal secretions into a sinus against normal ciliary activity,<sup>3</sup> it seems reasonable that a sinusitis may be induced, particularly if the mucosa has been traumatized by previous infection. I believe this sequence is illustrated in Case VIII in this series. If granted, this example serves to illustrate the development of an infective sinusitis by flight, in occasional cases. If flying in the presence of a rhinitis were not discouraged, this type of case might be observed with greater frequency.

#### SYMPTOMS AND SIGNS

Aerosinusitis is manifested generally by a sudden, severe, unremitting pain, boring in character and localized over the region of the affected sinus. The pain occurs abruptly during descent from regions of low atmospheric pressure in aircraft or chamber. Conceivably, the mechanism of this pain may be due to sudden stretching and separation of the mucoperiosteal tissues during the rapid swelling that follows plugging of the ostium.

Not all the mucosa of an involved sinus

may become swollen; bulky swelling of only part of the lining occurs often and presumably is limited by more rigid binding of the mucoperiosteum at the partial septa and at the angles between adjacent walls of the sinuses. Such swelling, easily demonstrated roentgenographically, may be edema or hematoma, and in either case, may be accompanied by transudation of fluid. It is not easy to differentiate edema from hematoma by the roentgenogram alone. The later appearance of dark red or brownish mucus, or even clots, establishes the presence of blood in the affected sinus, and may be the result of frank bleeding from the mucosa or seepage from a hematoma. The blood may remain in the sinus for a considerable period if patency of the ostium is difficult to establish, or early bleeding may occur when the obstruction can be relieved quickly.

Although the changes in the bony walls that are seen in the roentgenogram in chronic infective or chronic allergic sinusitis are not present in aerosinusitis, the latter would not be distinguishable from an acute allergic or infective sinusitis without the benefit of an adequate history and rhinological examination. Difficulty may be experienced also if an aerosinusitis is superimposed on an already diseased or traumatized sinus. These considerations emphasize the need for cooperation between the roentgenologist and the clinician in evaluating each case.

#### TREATMENT

Although the scope of this article is primarily diagnostic, it may not be amiss to mention briefly the treatment of aerosinusitis. The severe pain may be partly relieved sometimes by immediate re-ascent to higher altitude followed by slow descent. Thereafter, persistent and continuous shrinkage of the nasal mucosa at the ostium of the affected sinus is the only effective method, with use of a vasoconstrictor applied by spray or topical packs. The more prompt the re-establishment of ostial patency, the more rapid is the resolution of

the aerosinusitis. The neglected or incompletely treated case may be disabled for weeks. Symptomatic treatment consists of the use of external heat and small doses of codeine, and contributes to the comfort of the patient. Flying or altitude chamber excursions should be prohibited at least until beginning resolution is revealed by the roentgenogram. Total resolution is demonstrated by complete return to normal appearance of the sinus roentgenogram, which seems always to follow clinical subsidence. The superimposition of an aerosinusitis on a chronic infective or allergic sinusitis might prolong resolution further. The resumption of flying duty before complete clearing may be a matter of clinical judgment or may be justified in time of war by contingent factors of urgency.

#### REPORT OF CASES

**CASE 1.** This aviator flew on November 24, 1943. He developed acute pain over the right cheek during descent and the pain persisted on the ground for several hours. There was no bleeding. Nasal examination was essentially normal. Relief of pain was obtained after several instillations of a vasoconstrictor. There was no fever or other evidence of an infective process.

*Previous History.* No sinusitis or chronic rhinitis.

*Roentgen Findings.* November 26, 1943 (Fig. 1A): Mucosal swelling is obvious in the right antrum involving all the walls. March 4, 1944

(Fig. 1B): The right antrum now displays a normal appearance.

*Comment.* This case represents aerosinusitis of a relatively mild type, without evidence of sufficient trauma to cause bleeding, and with rapid clinical response to simple treatment.

**CASE 11.** While "descending" in the altitude chamber on June 1, 1944, this man developed extremely severe right frontal pain only slightly relieved by temporarily "ascending." The frontal pain persisted all day and bleeding occurred from the nose or nasopharynx into the throat in the evening. At the hospital that evening bilateral aero-otitis media was also found, more severe on the right side, with slight bloody oozing from the nose. A vasoconstrictor was applied topically to the ostium of the right nasofrontal duct and there followed a mucosanguineous discharge from the duct. The patient improved progressively with constant shrinkage therapy. There was no laboratory evidence of blood dyscrasia.

*Previous History.* No sinusitis or chronic rhinitis.

*Roentgen Findings.* June 2, 1944 (Fig. 2A): There is bulky mucosal swelling (hematoma?) in the right frontal sinus and moderate swelling in the medial portion of the left frontal sinus. June 5, 1944 (Fig. 2B) and June 6, 1944 (Fig. 2C): There is increased mucosal swelling in both frontal sinuses, particularly the right, which displayed a fluid level. July 17, 1944 (Fig. 2D): There is well advanced resolution of the sinusitis in the right frontal sinus with appreciable residual thickening of the mucosal shadow along

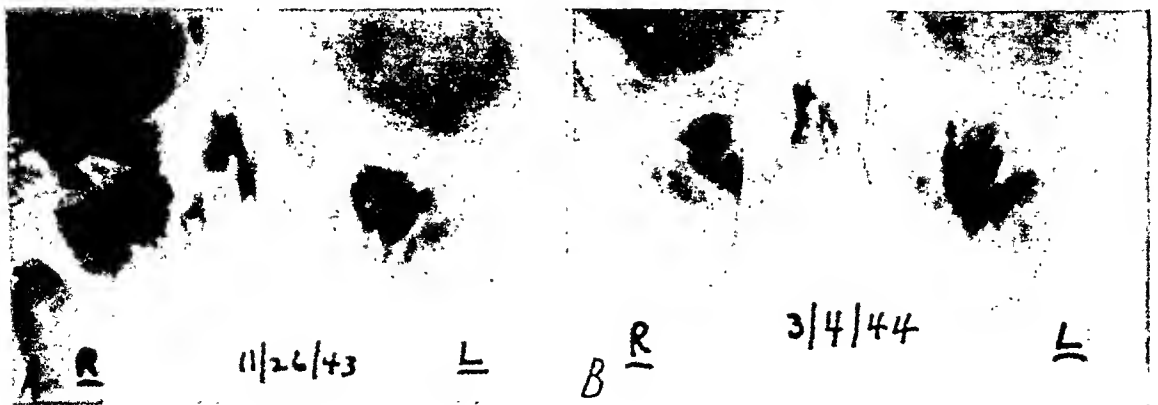


FIG. 1. Case 1. A, November 26, 1943. Mucosal swelling in the right antrum involving all the walls. B, March 4, 1944. Both antra are now clear.

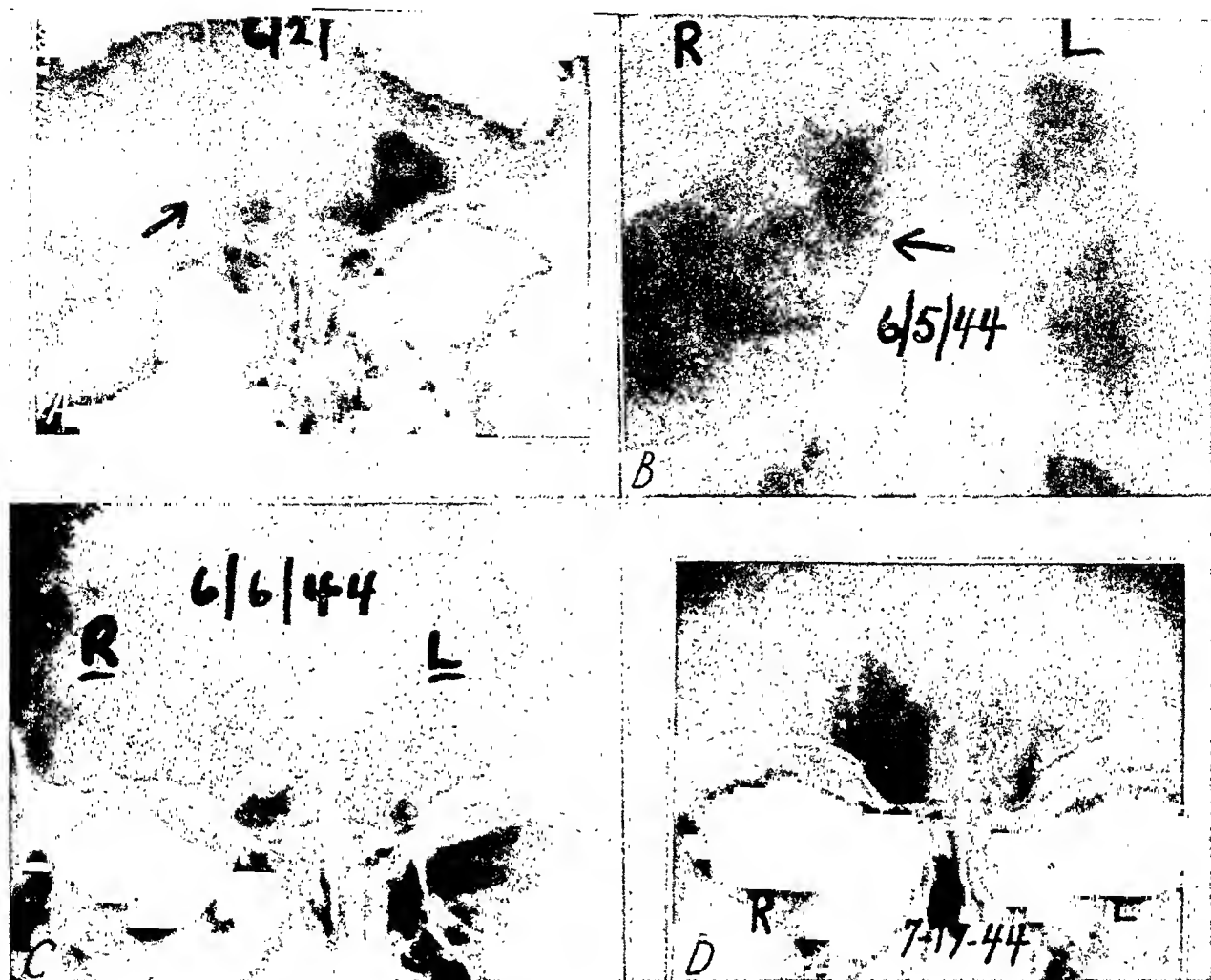


FIG. 2. Case 11. *A*, June 2, 1944. Severe mucosal swelling in the right frontal sinus may be hematoma. There is haziness below the area of swelling, apparently due to free fluid (shown in *B*). The medial wall of the left frontal sinus shows some mucosal thickening also. *B*, June 5, 1944. Upright Waters position demonstrates a fluid level (arrow) in the right frontal sinus. *C*, June 6, 1944. The free fluid in the right frontal sinus has apparently now been drained, disclosing the bulky mucosal swelling in sharper contrast and slightly greater size. *D*, July 17, 1944. Almost complete resolution of the process in each frontal sinus. There is still some mucosal thickening in the right frontal sinus, but the bulky shadow is absent.

the lateral wall and roof, and mild persistent clouding of the left frontal sinus.

*Comment.* A complicating aero-otitis media occurred in this case but the existence of blood in the right frontal sinus was established following shrinkage about the ostium of the right nasofrontal duct. It is probable that the bullous swelling in the right frontal sinus, demonstrated roentgenographically, was a mucosal hematoma.

CASE III. On August 15, 1943, this soldier experienced excruciating pain over the left brow while "descending" in the altitude chamber. The nasal mucosa appeared normal on physical

examination. A bloody discharge from the left naris appeared the next day and continued with occasional small clots for several days. The pain subsided slowly with intranasal vasoconstrictor therapy.

*Previous History.* Non-contributory. Nose clear to examination.

*Roentgen Findings.* August 16, 1943 (Fig. 3*A*): A bulky mucosal swelling (hematoma?) appears in the left frontal sinus with no fluid level. March 25, 1944 (Fig. 3*B*): Normal appearance of the frontal sinuses is demonstrated.

*Comment.* The progress of resolution could not be followed in this case, unfortunately. The second roentgenogram is

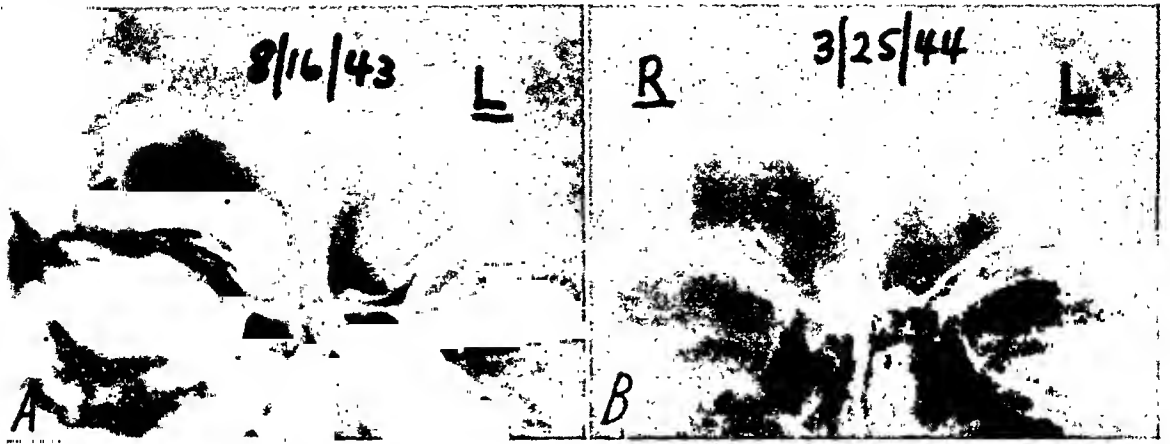


FIG. 3. Case III. *A*, August 16, 1943. The bulky shadow in the left frontal sinus is well demonstrated. *B*, March 25, 1944. Normal appearance of the frontal sinuses.

shown to indicate the normal appearance of the frontal sinuses at a later date. Here again, the bloody discharge is evidence to suggest that the left frontal sinus contained a mucosal hematoma.

**CASE IV.** During "descent" in the altitude chamber on March 3, 1943, stabbing pain was experienced over the left cheek bone radiating toward the nose. The pain persisted about twenty-four hours, subsiding under treatment.

*Previous History.* No chronic rhinitis or sinusitis; no history of allergy.

*Roentgen Findings.* March 3, 1943 (Fig. 4*A*): Bulky mucosal swelling is visualized in the left antrum. March 11, 1943 (Fig. 4*B*): Both antra

are now radiant. (This individual has had two subsequent attacks of aerosinusitis, one in the left antrum and one in the right, with bloody discharge during the course of the left antral aerosinusitis; both these episodes occurred during "descent" in the altitude chamber.)

*Comment.* In the absence of any evidence of chronic nasal or sinus disease, it is interesting that this soldier experienced several attacks of aerosinusitis of the antra. The pain was as severe as any I have seen but response to conservative treatment was reasonably prompt. Bleeding occurred only during the course of the second episode af-

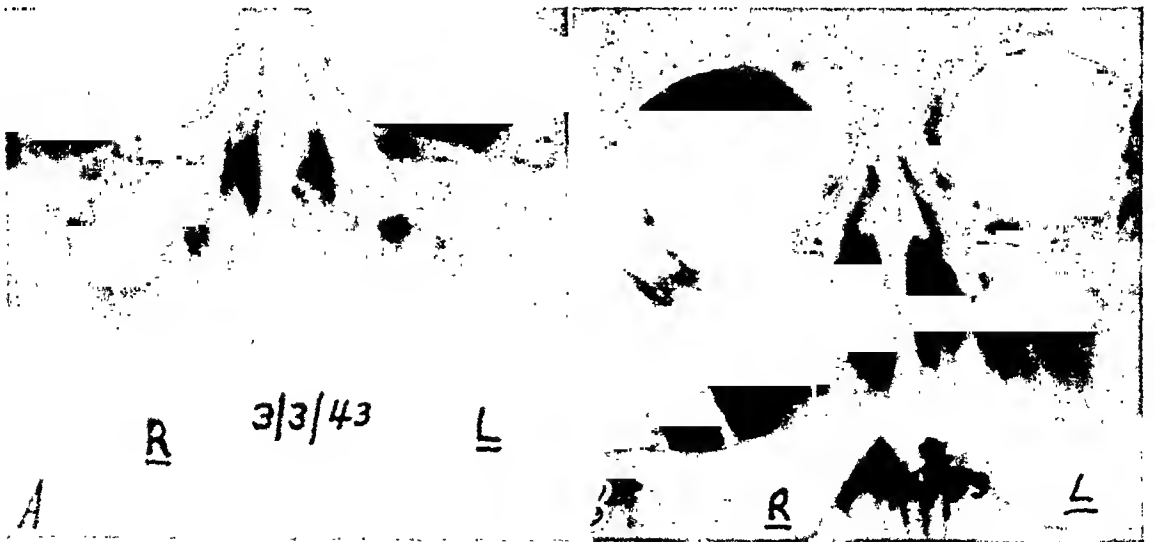


FIG. 4. Case IV. *A*, March 3, 1943. Generalized bulbous mucosal swelling in the left antrum. *B*, March 11, 1943. Rapid resolution is apparent, with the left antrum now radiant.

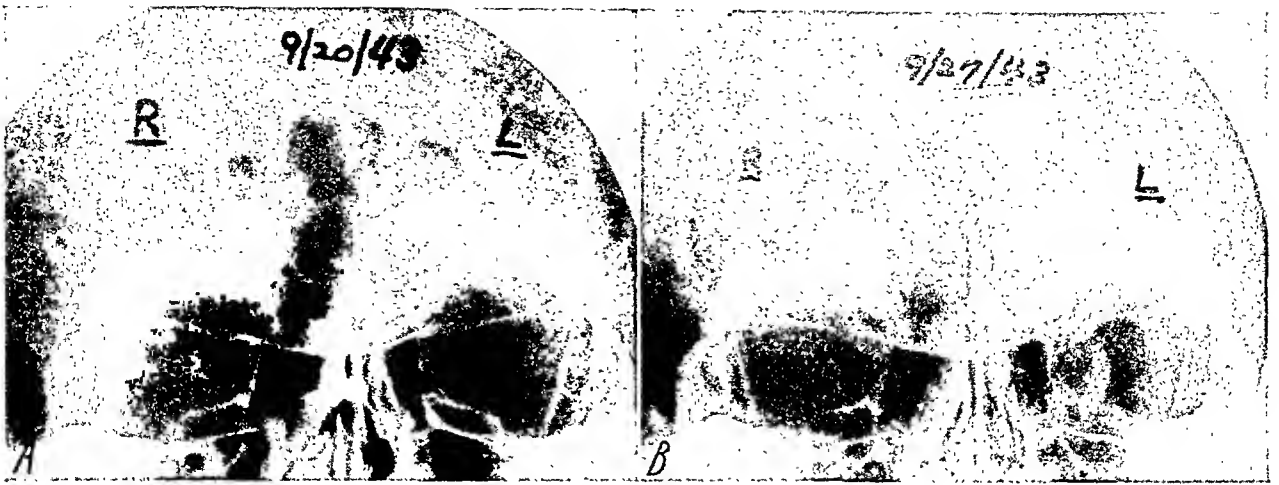


FIG. 5. Case v. *A*, September 20, 1943. A bullous mucosal shadow is in the right frontal sinus, and the left frontal sinus is hazy. *B*, September 27, 1943. The mucosal swelling in the right frontal sinus is smaller; apparently absorption is taking place.

fecting the left antrum. This may have been an effect of the residual mucosal damage following the first episode described above, or it may have been due to a possible difference in degree of the pressure differentials established.

**CASE v.** During descent in an airplane, there was a sudden pain over the right brow accompanied by moderate, dull pain over the left frontal sinus. The pain was completely relieved in forty-eight hours with intranasal vasoconstrictor therapy. On examination, there was a slight mucoid discharge from the right nasofrontal duct, but the nose was otherwise clear.

**Previous History.** No history of allergy, chronic rhinitis or sinusitis.

**Roentgen Findings.** September 20, 1943, (Fig. 5*A*): There is haziness of the left frontal sinus and a sharply demarcated, bulky mucosal swelling in the right frontal sinus. No fluid level was demonstrable in either sinus. September 27, 1943 (Fig. 5*B*): There is a sharp decrease in the extent of mucosal swelling in the right frontal sinus and improvement in the appearance of the left frontal sinus. (Further follow-up not available.)

**Comment.** The occurrence of changes in both frontal sinuses, demonstrated in this case and in Case II, is unusual. There was apparently a marked quantitative difference in the reaction as demonstrated roentgenographically, with a milder but more

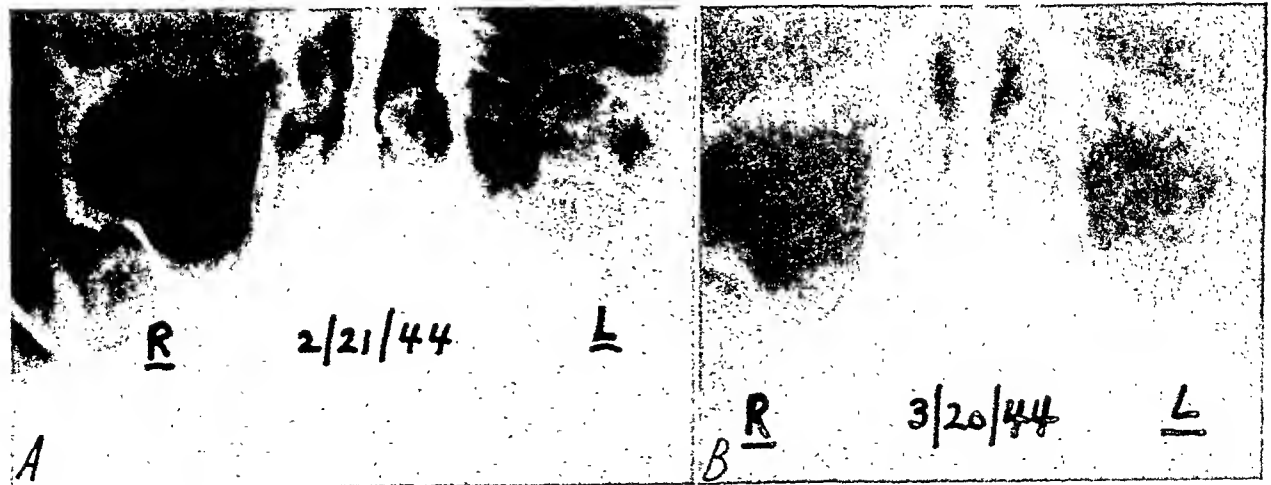


FIG. 6. Case vi. *A*, February 21, 1944. Obvious and severe mucosal thickening involves the left antrum. *B*, March 20, 1944. The antra are radiant.



generalized mucosal thickening in the left frontal sinus. It may be observed, speculatively, that such a bilateral occurrence may be due to particularly marked narrowness or tortuosity of the nasofrontal ducts in these individuals.

**CASE VI.** Acute pain over the left malar prominence occurred suddenly and radiated to the left maxilla during descent in an airplane on February 20, 1944. The sharp pain persisted for twenty-four hours and gradually subsided

pain partially subsided and the next day he flew again, only to suffer a recurrence of the attack. He reported to the hospital then and was treated with a vasoconstrictor applied by topical pack and nose drops, supplemented by physiotherapy. Under this treatment his pain subsided slowly and was completely relieved in seventy-two hours. A yellowish mucoid discharge occurred from the left naris on June 18, 1944.

*Previous History.* Non-contributory.

*Roentgen Findings.* June 14, 1944 (Fig. 7*A*):

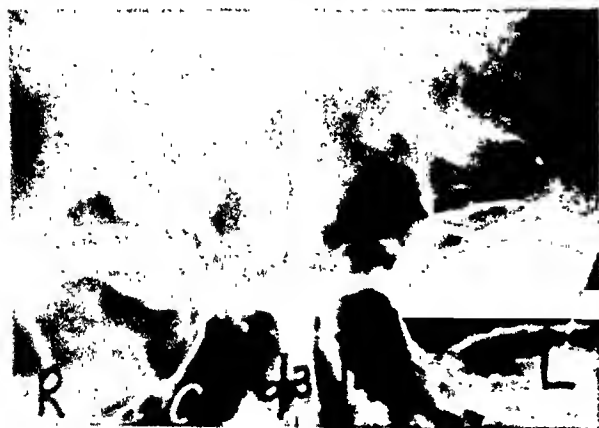


FIG. 7. Case VII. *A*, June 14, 1944. A band-like mucosal swelling (arrow) involves the floor of the left frontal sinus. *B*, June 17, 1944. The lesion is still present. *C*, June 30, 1944. The involved sinus is now clear.

thereafter under treatment. The nose was clear on examination.

*Previous History.* Non-contributory.

*Roentgen Findings.* February 21, 1944 (Fig. 6*A*): Hyperplastic mucosal changes in the left antrum are visualized. March 20, 1944 (Fig. 6*B*): The left antrum is completely clear.

*Comment.* This is a typical and clear-cut case of arosinusitis in one antrum.

**CASE VII.** During an airplane flight on June 14, 1944, this young aviator experienced a sudden, excruciating pain over the left brow radiating to the internal canthus of the left eye. The

There is a band of mucosal swelling across the floor of the left frontal sinus. June 17, 1944 (Fig. 7*B*): The mucosal swelling in the floor of the left frontal sinus is persistent. June 30, 1944 (Fig. 7*C*): The mucosal swelling previously visualized is now absent.

*Comment.* A recurrent attack of arosinusitis in twenty-four hours is uncommon inasmuch as medical attention is usually sought as soon as possible. This flyer, anxious to lose no flying time, unfortunately exposed himself to the recurrence which brought him to the hospital. Although his

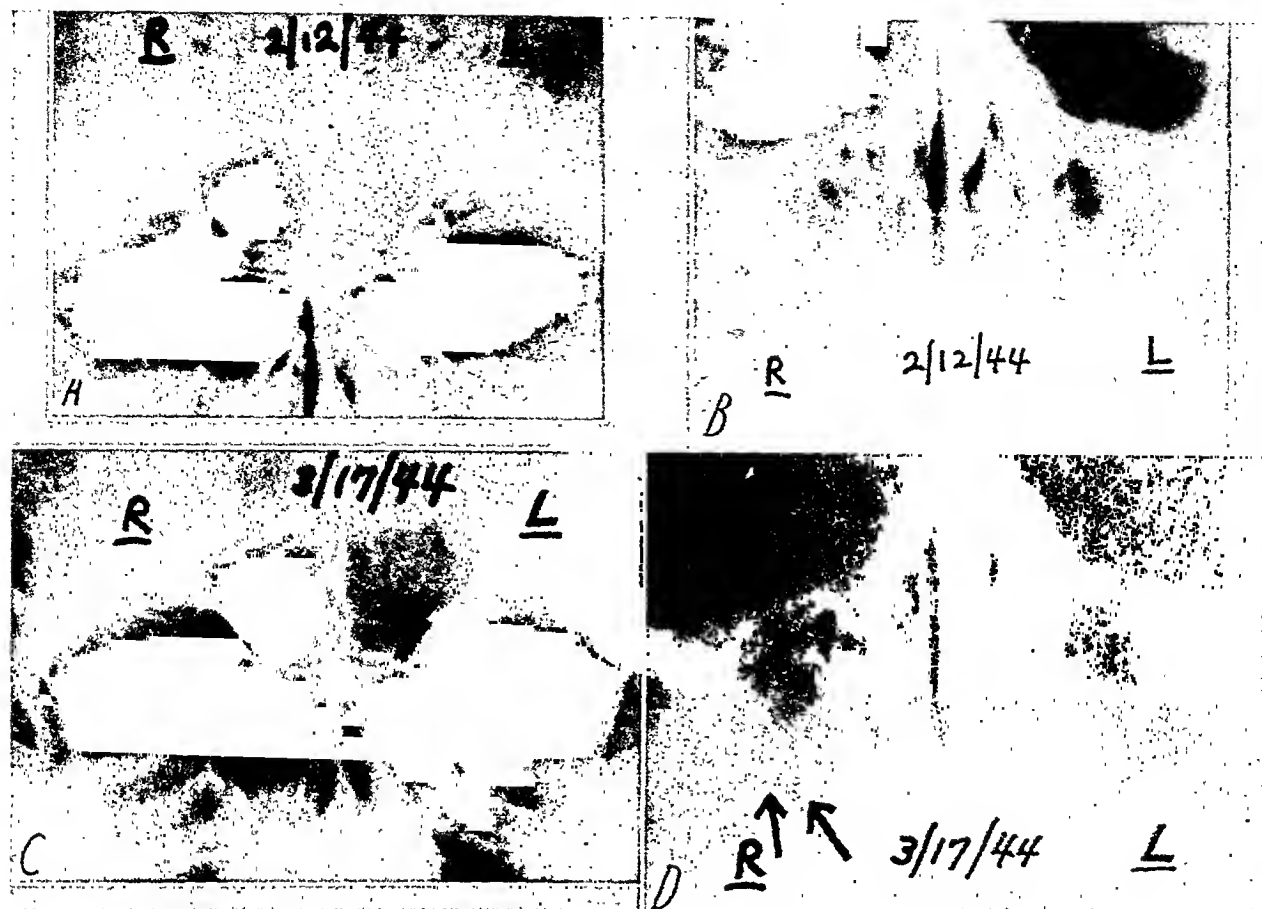


FIG. 8. Case VIII. *A* and *B*, February 12, 1944. A hyperplastic sinusitis involves the frontal and maxillary sinuses. The left frontal sinus is almost opaque; the right frontal sinus displays bulky mucosal swelling on the roof and medial wall (arrows). *C* and *D*, March 17, 1944. Considerable resolution has occurred but there is still mucosal swelling in the right antrum (arrows) and haziness in the left frontal sinus.

pain persisted for three days before complete relief was obtained, roentgenographic clearing of the affected sinus was evident in about two weeks.

**CASE VIII.** This officer flew on February 10, 1944, despite a mild rhinitis. During descent an aching sensation occurred, localized over both antra and brows. A febrile course ensued in the hospital, with a mucopurulent bilateral nasal discharge, and gradual improvement under conservative measures. A rhinitis was apparent to physical examination.

**Previous History.** There had been several episodes of sinusitis before this patient began to fly. The most recent attack occurred some two years ago. There was no history of allergy.

**Roentgen Findings.** February 12, 1944 (Fig. 8*A*): There is marked mucosal thickening in the antra and frontal sinuses. March 17, 1944 (Fig. 8*B*): The appearance of the involved sinuses is greatly improved, but the right antrum displays residual mucosal swelling along its lateral

and medial walls. The left frontal sinus displays haziness which may be residual or chronic. The left antrum and right frontal sinus are clear.

**Comment.** The atypical onset, febrile course, mucopurulent nasal discharge and history of previous sinusitis suggest that this case may represent a sinusitis induced by aspiration of infected nasal secretions in the presence of an acute rhinitis (see text).

#### SUMMARY

1. Aerosinusitis is a traumatic affection of the paranasal sinuses, characterized by dramatic, sudden, severe pain localized over the affected sinuses and occurring during descent from altitude in an aircraft or altitude chamber.

2. Its immediate cause is apparently sudden obstruction of a sinus ostium, as by a mucous plug or loose mucosal membrane, thereby sharply and radically increasing

the relatively negative intrasinus pressure which presumably exists already in the sinus during descent.

3. The intense pain of this condition is attributed to sudden ballooning of the sinus mucoperiosteum induced by the great negative pressure. Edema and transudation in the sinus may occur and may be accompanied by hematoma and/or frank hemorrhage.

4. The roentgenographical appearance and the history are characteristic in this disorder, as illustrated by the appended case histories and serial roentgenograms.

5. It is also possible that the pressure gradient may lead to an infective sinusitis by forcing aspiration of infected nasal secretions into a sinus previously damaged by infection.

6. Aerosinusitis is a subject of importance in aviation medicine. It results in loss of man-hours and may jeopardize safety by the intense and even agonizing discomfort during aerial flight.

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## SOLITARY MYELOMA OF THE FRONTAL BONE\*

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**S**OLITARY myeloma is a rare type of tumor, and when found in association with osteitis deformans the diagnostic problem becomes even more confusing because of the much more common combination of Paget's disease and sarcoma. The present case is reported because of the problem it posed in differential diagnosis.

In 1943, Esposito reported a case of solitary myeloma of the skull, stating that of the 46 cases he found in the literature only 5 were in the skull. His case made 6, and the present case makes seven.

Briefly, the problem presented to us was as follows:

A well nourished female, aged forty-two, a housewife active in her work, had been complaining of some indefinite headaches for a period of about four years. She had a roentgen examination of her skull shortly after the pains became a factor, at which time the presence of Paget's disease was demonstrated, but there was no defect in the calvarium. During the next three years she saw several doctors until finally she was sent into the hospital for an additional roentgen examination because a swelling had appeared in the left post frontal region which was slightly tender and quite hard. The roentgenogram obtained at this examination is shown in Figure 1.

This presented a real problem in differential diagnosis. Sarcoma would immediately be thought of because sarcoma is not infrequently found associated with Paget's disease, but it is indeed rare to find such an association in the skull. In fact, sarcoma of the skull, especially of the calvarium, is extremely rare, probably because of the membranous origin of this portion of the skull. When sarcoma does occur it is apt to follow sutures in much the same manner as does the sympathicoblastoma or neuroblastoma. Hence it seemed possible to eliminate sarcoma as a likely diagnosis. By the history it was not of traumatic origin, hence we could rule out a leptomeningeal or hematogenous cyst. The history also ruled out in large measure any pos-

sibility of its being due to an infectious cyst or eosinophilic granuloma.

The lesion obviously was not a metastasis because its outline was too distinct, and the patient was in relatively good health. A much more likely lesion and one much more difficult to rule out was an epidermoidoma. Such a tumor could duplicate the lesion seen, but the margins of the defect in question were not clearly defined around the entire area and the



FIG. 1. Defect in frontal bone caused by solitary myeloma.

swelling was not typically fusiform. The diploë was not expanded so that the margin did not present a line of increased density as we so often find with the epidermoidomas.

Thus it was possible to eliminate most of the probable diagnoses, and about the only remaining type of tumor which could produce such a bone defect would be a myeloma. Inasmuch as there was no evidence of more than one lesion, it was thought that we were dealing with a solitary type of this neoplasm, which was the

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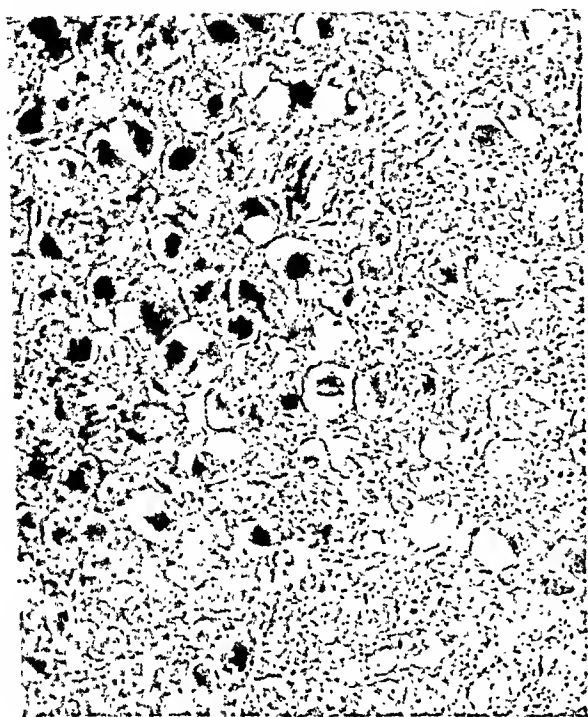


FIG. 2. Photomicrograph of biopsy specimen.

diagnosis offered as the most probable. But inasmuch as there was a possibility that the lesion might be an atypical epidermoidoma, and as the treatment for these two tumors is quite different, it was considered wise to obtain the aid of the surgical department for a biopsy study. A biopsy was done by Dr. H. A. Vier and the report of the pathologist, Dr. P. T. McIlroy, was as follows:

"The biopsy specimen removed from the temporal bone presents a pinkish white homogeneous cellular appearance throughout. It measures 2 cm. in length and 0.5 cm. in width. Microscopic examination showed the growth made up of large numbers of multinucleated cells supported by a stroma of spindle and oval shaped connective tissue cells which are lying in a small amount of collagen fibril. It resembles histopathologically the solitary tumor found in the epiphyseal end of long bones. The accompanying photomicrograph (Fig. 2) shows the relatively large numbers of myeloplaxes. The diagnosis was giant cell myeloma of the skull."

The patient's urine was examined for Bence-

Jones bodies but none were found. It seems likely, however, that this albuminoid substance is produced by lesions in the red bone marrow and therefore would not be expected to exist in cases involving only the skull, and particularly when the lesion is only in the calvarium, because of its membranous origin.

Upon confirmation of the diagnosis by the pathologist, radiotherapy was decided upon as the treatment of choice, and the lesion was treated over a period of eight days during which time a total of 1,274 r was administered in divided doses using 200 kv., with filtration of 0.25 mm. Cu plus 1 mm. Al, through a single field over the tumor. The tumor mass gradually regressed until at the end of a month a depression instead of an elevation could be felt over the area. At this time another series of treatments was given, consisting of 1,554 r administered in divided doses over a period of twelve days, using the same factors as before. After the lapse of about a year, bone could be demonstrated filling in the defect and as might be expected the new bone was typically that of osteitis deformans. Paget's disease is now the patient's chief complaint because the pathological condition is not confined to the skull, and bone pain elsewhere is a factor.

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# DISSEMINATED CALCIFIED AND BONY NODULES IN THE LUNGS ASSOCIATED WITH MITRAL DISEASE\*†

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THE roentgenographic examination of the lungs in long-standing cardiac disease may simulate, on occasion, hematogenous tuberculosis, silicosis or sarcoidosis. Indeed, in the literature the finding of disseminated calcified or ossified nodular densities has only rarely been included in discussions of pulmonary findings associated with chronic heart disease.<sup>1,3,7,12,17</sup> In 2 cases<sup>10</sup> calcified or ossified pulmonary nodules were found in association with mitral stenosis, but the relationship was not stressed specifically. Roesler<sup>15</sup> mentions and illustrates one instance and, following Virchow's terminology,<sup>19</sup> speaks of "multiple osteomata." Wells and Dunlap<sup>20</sup> recently published the postmortem findings in a case which unfortunately was not examined roentgenographically during life. These authors presented the pathological and histological features in great detail, summarizing the case reports in the literature and discussing extensively the possible etiology. No other mention of this association of lesions has been found in the English or American literature.

The first description correlating the roentgenographic and pathologic findings was given by Salinger<sup>16</sup> in 1932: a patient with long-standing mitral stenosis presented numerous nodular shadows of calcium density in both lower lungs along with the clinical and roentgenographic findings of mitral stenosis and insufficiency. Postmortem examination revealed them to be nodular bone formations in the lungs. Although such nodules had been observed prior to this report, their connection with mitral stenosis had not been discussed before. Since Salinger's description, several scattered case reports have appeared in the

German and French literature.<sup>2,8,9,11,21</sup> All of the cases were associated with mitral stenosis.

The present report is an attempt to correlate the roentgenographic, pathologic and clinical findings in 8 cases. The significant details of the history, clinical, roentgenographic and pathological examinations are presented in tabular form. All of the 8 cases presented suffer from mitral stenosis and insufficiency and present nodular calcific shadows in both lung fields. In 4 cases, the lesion was discovered preceding the first episode of congestive heart failure. One case (Case VIII) has never had clinical congestive heart failure.

## DISCUSSION

The pathogenesis of the pulmonary lesions is not clear. Since the majority of cases examined postmortem showed only bone formation, it is assumed that the transitional stages are short lived and occur in the early phases of the disease. The explanation offered by Gross,<sup>8</sup> and Gross and Müller,<sup>9</sup> and accepted by Wells and Dunlap<sup>20</sup> assumes:

1. Transudation of plasma and red blood cells into the alveolar spaces due to pulmonary vein congestion.
2. Disturbed resorption due to persistent pulmonary venous congestion and co-existent pulmonary lymphatic congestion.
3. Organization of the transudate by connective tissue.
4. Secondary calcification of these areas which is facilitated by the presence of hemosiderin.
5. Subsequent transformation into bony tissue through osteoblasts which form

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† Gratitude is extended to Dr. J. G. Sharnoff, pathologist, Lincoln Hospital for allowing the use of the postmortem material of Case v.

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TABLE I

Clin. No.	Chief Diagnosis	Name	Sex	Age	First Attack Rheumatic Fever	Recurrent Rheumatic Fever	Episodes of Congestive Heart Failure and Clinical Course	Episodes of Congestive Heart Failure Preceding Discovery of Calcified Lesions	Röntgen Findings
i	Mitral stenosis and insufficiency; giant left auricle; relative tricuspid insufficiency; auricular fibrillation; chronic congestive heart failure	S.N.	M	23	At age of 13 yr.	At age of 22 yr.	At age of 23; acute pulmonary edema. Discharged after one month of hospitalization where he received digitalis with marked improvement	None	The heart shows a marked prominence of middle segment of the left cardiac contour. Elevation of the right cardiac suprasternal junction. Double contour on right cardiac border; large left auricle. Bilateral congestion bilaterally. Numerous calcified nodular shadows in both lower lung fields from pinpoint to pea size (see fig. 1)
ii	Mitral stenosis and insufficiency; giant left auricle; relative tricuspid insufficiency; auricular fibrillation; chronic congestive heart failure	L.N.	M	31	8 yr.	24 and 30 yr.	At age of 26, gradually progressing. Died at 31 of advanced congestive heart failure predominantly right sided. No post-mortem	Pulmonary lesions were discovered only five years after onset of congestive heart failure. No previous roentgenograms available	The heart is greatly enlarged to the left and to the right and of triangular shape. A double contour is visible on the right cardiac border. The right auricle extends to the right anterior axillary line. The mitral valve is calcified. The left bronchus is almost horizontal. The hilar vascular shadows are very prominent. There are numerous calcified nodular shadows in both lower lung fields from pinpoint to pea size (over-penetrated and fast Potter-Bucky technique).
iii	Mitral stenosis	R.J.	F	31	7 yr.	14, 24 and 31 yr.	First episode with onset of auricular fibrillation at 24. Chronic congestive heart failure since	None. Report of pulmonary roentgen findings during first episode of heart failure: "there are small calcified deposits throughout both lower lobes more or less symmetrical"	The heart is enlarged to the left and somewhat to the right. The left middle segment is prominent and elongated. A double contour is present on the right cardiac border. There are very numerous calcified nodular shadows present in both lower lung fields from pinpoint to pea size (fig. 2 and 3).
iv	Mitral stenosis and insufficiency; pulmonary intarction; right-sided pleural effusion	S.K.	M	35	10 yr.	27 and 35 yr.	At 27; chronic congestive heart failure since	At 35 episode of massive right-sided pulmonary infarction with sanguinous right pleural effusion. Only roentgenograms of this admission available	The heart shows considerable prominence of the lower and upper arc of the left middle segment as seen in left auricular enlargement. An effusion occupies the lower posterior portion of the right pleural cavity. The visible pulmonary segments are moderately congested. Numerous calcified nodular shadows can be seen in the left lower lung field; mostly of lentil to pea size (right lower lung field obscured)



v	Mitral stenosis and insufficiency; angina pectoris	A.H.	M	29	Chorea at 7 yr.	Apparently none	At age of 29 leading to death; post-mortem	None. First chest roentgenogram taken 6 yr. before onset of heart failure (for angina pectoris) showed lesions	The heart is moderately enlarged to the left with a considerable prominence of the left middle segment. The pulmonary vascular markings are slightly increased. Widely disseminated calcified nodular shadows are seen in both lung fields, most numerous in the lower portions. Histological examination showed these areas to consist of bony tissue (Fig. 4, 5, 6 and 7)
vi	Mitral stenosis and insufficiency	B.A.	M	45	? cardiac murmur covered at age of 21		Onset of auricular fibrillation and congestive heart failure at 32 yr. Cerebral embolism 2 yr. later. Died of congestive heart failure. No post-mortem	Chronic congestive heart failure for at least 10 yr. prior to discovery of pulmonary lesions	The heart is considerably enlarged to the left; the left middle segment is markedly prominent; slight enlargement to the right. The pulmonary artery branches are markedly prominent. There is a right pleural effusion. Numerous calcified nodular shadows in both lower lung fields
vii	Mitral stenosis	H.B.	M	35	Chorea and rheumatic fever at 11 yr. Cardiac murmurs discovered at 15 yr.	None	Increasing dyspnea for past 2½ yr. improving on digitalis. Recent episode of cough, pain in right chest and bloody expectoration; pulmonary infarction. Improved	2½ yr. of heart failure preceding discovery by roentgen examination of pulmonary nodular shadows	The heart is moderately enlarged to the left and right. The middle segment of the left cardiac contour is elongated and prominent. Both lower lung fields are moderately congested. The pulmonary artery branches show a considerable prominence. Numerous small calcified nodular shadows are present in both lower lung fields
viii	Mitral stenosis and insufficiency	P.S.	F	31	? murmurs discovered at age of 18 yr.		Dyspnea on climbing stairs for past 4 years	No history or any finding of acute or chronic decompensation	The point of opposite pulsations is considerably lowered. Both arcs of the middle segment are prominent. A double contour is visible at the upper third of the right cardiac contour. Numerous calcified nodular shadows are visible in both lower lung fields, varying considerably in size



FIG. 1. Case 1. S. S., male, aged twenty-three. *A*, mitral configuration with hilar congestion. Note the basal distribution of the calcium dense lesions. *B*, enlarged section of right lower lung field.

haversian canals and bone marrow. This type of metaplasia occurs quite often in calcified tissues, particularly in tuberculous lesions (see Pollack<sup>11</sup> for detailed discussion).

Although these steps in development appear plausible, it is difficult to accept them entirely, since in many of the cases in the literature, as well as in 4 described here, the lesions were already established before any clinical congestive heart failure appeared. There is no evidence in any of the cases studied histopathologically that pulmonary arteritis or small pulmonary infarctions are precursors to such lesions, but the tissues which have been studied are an end-result where the original pulmonary changes occurred long before. Attention is called to the lack of knowledge of the pathogenesis of these nodules, with the suggestion that careful inspection of the lungs by the pathologist in cases of adolescent or pre-adolescent rheumatic fever may yield significant data. The clinical histories of the reported

cases suggest strongly that the precursor to these lesions must appear early in rheumatic fever and probably in childhood. It would seem that factors other than or in addition to vascular congestion must be involved even though the predominant and sometimes exclusive distribution of the nodules at the bases favors congestive factors and their sequelae.

#### DIFFERENTIAL DIAGNOSTIC CONSIDERATIONS

The purpose of this report is to draw attention to the coexistence of disseminated calcified and bony lesions in the lungs and rheumatic mitral disease. The findings may be so insignificant as to be overlooked, especially when overshadowed by an enlarged heart, pleural effusions or pulmonary edema. On the other hand, the dissemination of these densities may be marked and they are apt to be considered "healed miliary tuberculosis." The occurrence of the latter is so infrequent, particularly in the calcified disseminated nodular phase, that some authors doubt its existence entirely.

Other possible etiological factors in the production of such a roentgenographic picture have been considered by various authors. These have included *Ascaris* infestation of the lungs, aspergillosis, and coccidiomycosis. However, no convincing evidence has been found that any of these conditions are responsible for disseminated calcified or ossified nodules.<sup>1,3,4,5,6,7,12,17,18</sup> For practical purposes the only important

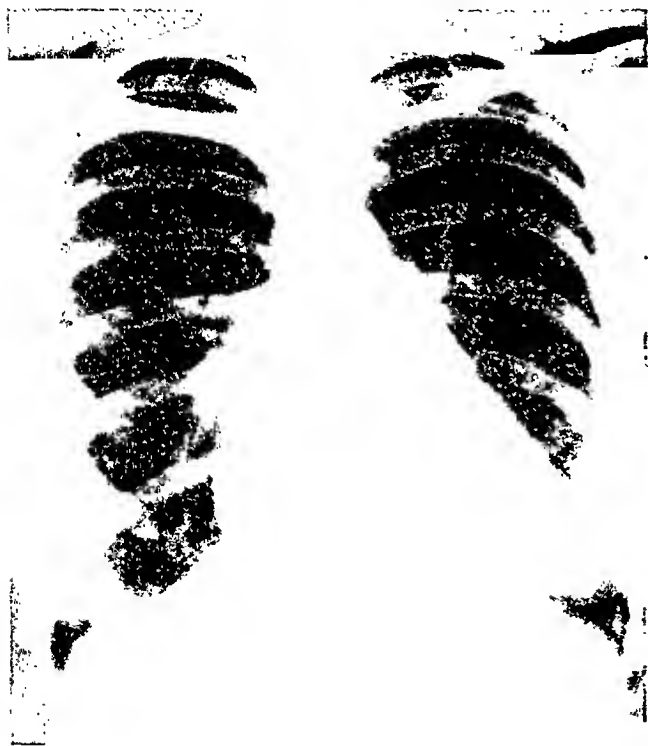


FIG. 2. Case III. R. I., female, aged thirty-one. Mitral configuration. Again the calcium dense lesions are seen to be distributed over both lower lung fields.

condition to be considered in the differential diagnosis is pulmonary tuberculosis. Although tuberculosis might be considered by some as an etiological possibility in these cases, the peculiar association with rheumatic mitral disease and its distribution characteristics would remain to be explained.

#### DISSEMINATED CALCIFIC AND OSSIFIED NODULES IN THE LUNG

##### Associated with Rheumatic Heart Disease

1. Predominantly basal bilateral distribution, occasionally extending upward toward but not involving the apices.



FIG. 3. Case III. Right lower lung field. Note the varying size of the lesions.

2. Associated with evidence of mitral stenosis and insufficiency. It is not necessary that the

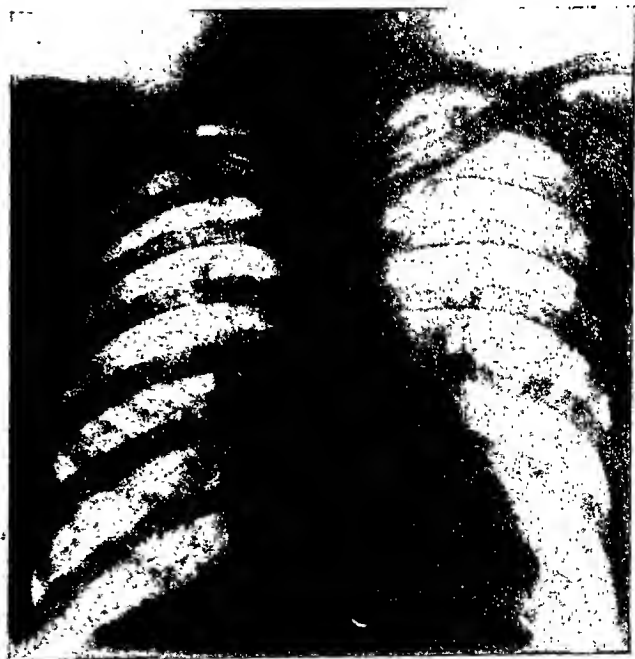


FIG. 4. Case V. A. H., male, aged twenty-nine. Predominant distributions of nodules in both lower lung fields.



FIG. 5. Case v. Right lower lung field. Note the varying size and shape of nodules.



evidence of rheumatic valvular change be marked or striking. Evidence of pulmonary congestion, acute or chronic, past or present, need not be present.

3. Absence of other evidence of pulmonary tuberculosis, active or inactive.

#### Associated with Pulmonary Tuberculosis

1. Sporadic hematogenous dissemination of tuberculosis usually involves predominantly the upper lung fields.

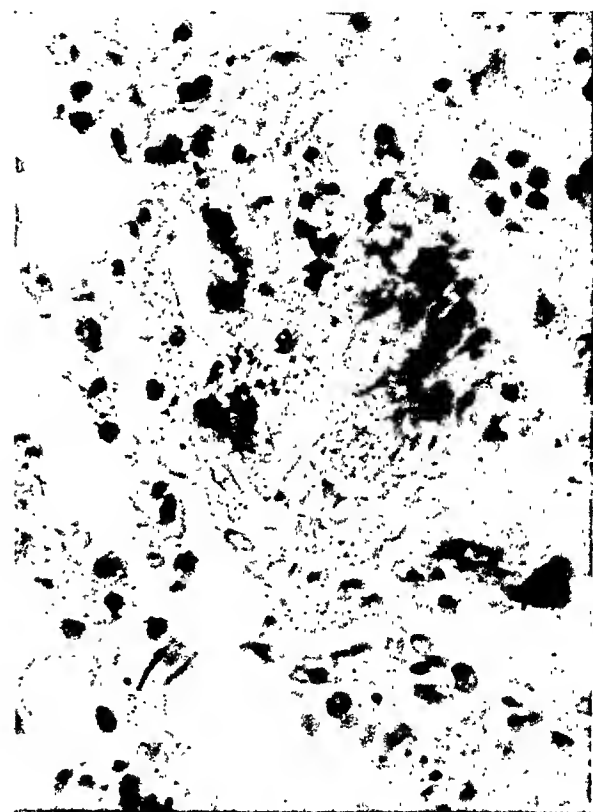


FIG. 7. Case v. In only one section could an area of calcification with central bone formation be seen. Only Munk's case<sup>13</sup> showed a similar picture.

2. Bronchogenic disseminations of tuberculosis, though frequently basal are associated with evidence of the source lesion in the upper lung fields and are more apt to be unilateral except when an intrabronchial hemorrhage has occurred.
3. Primary calcified or ossified tuberculous foci, though frequently basal, are rarely multiple.

FIG. 6. Case v. Histopathologically the nodules consisted of bony tissue.

4. Post-primary dissemination will usually be subject to the above hematogenous or bronchogenic distribution characteristics, and accompanied by other evidence of the parent lesion or lesions.
5. Healed calcified cases of chronic hematogenous dissemination are very rare, the nodular lesions when seen will usually vary more in size and will not be entirely, or predominantly, basal.

## SUMMARY

Eight cases of mitral stenosis and insufficiency with disseminated nodular calcified deposits and bone formation in the lungs have been presented. The association of these findings and the gap in our knowledge of their pathogenesis have been reviewed. The essential triad of differential diagnostic features has been stressed.

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# MALIGNANT GIANT CELL TUMOR OF THE LUNG\*

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THE lung is a very common site of primary epithelial tumors but instances of sarcoma are infrequently encountered. The following case is reported for its unusual histopathological features.

## REPORT OF CASE

A. W., a white male, aged forty-seven, was admitted for the second time on September 26,

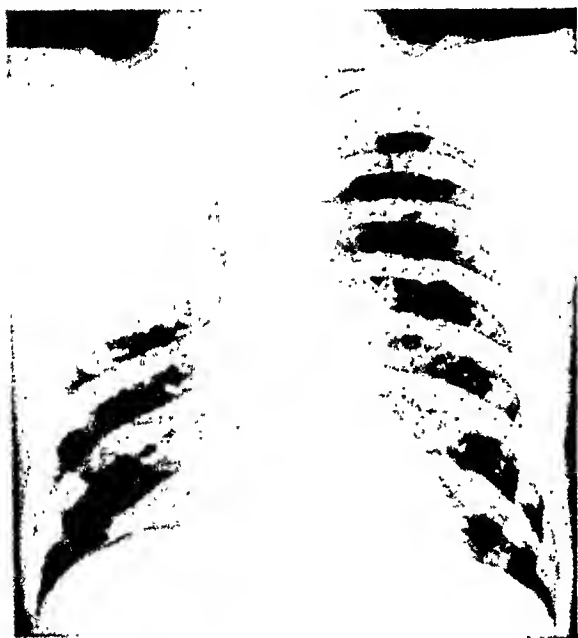


FIG. 1. Patient A. W. Roentgenogram of chest taken on October 7, 1939.

1939. In 1932 there was a brief episode of poly-articular pain and swelling. On his first admission, August 27, 1935, he complained of precordial pain and dyspnea of six months' duration. The roentgenogram of the chest showed slight widening of the aortic arch and the lung fields were clear. He was discharged on September 7, 1935, with the diagnosis of hypertensive and arteriosclerotic heart disease. In July, 1939, the patient developed pains in the ankles, knees, elbows, wrists and fingers. He was treated at home and returned to work three weeks later. A few days before admission, he noted chills and palpitation. There were no respiratory symptoms or loss of weight.

The patient was acutely ill with a temperature of 104.6° F., pulse 100 and respirations 24. There was dullness over the right upper lobe posteriorly with diminished breath sounds. The liver extended two fingerbreadths below the costal margin. There were swelling, tenderness, and limitation of motion of the ankles, knees, elbows and wrists and fingers, and clubbing of the fingers was marked. Except for a slight leukocytosis, the urine, blood chemistry, and blood count were within normal limits. The sputum was negative for tubercle bacilli. Roentgen studies revealed a periostitis of the clavicles, tibiae, fibulae and bones of the hands. Within the right upper lateral lung field was a spherical homogeneous density which extended from the apex to the third anterior rib (Fig. 1). Bronchoscopy demonstrated an intact bronchial mucosa. A diagnostic pneumothorax resulted in some downward displacement of the roentgen shadow. A small effusion subsequently formed and sterile serosanguineous fluid was aspirated. The patient ran an irregular type of fever throughout his hospital course. He developed cough with scanty expectoration and pain in the right chest. In the latter part of November, auricular fibrillation and pitting edema of both lower extremities appeared. He was given digitalis and diuretics with temporary improvement. The patient died suddenly on December 26, 1939.

Postmortem examination was done three hours after death. The right pleural cavity was entirely obliterated by diffuse dense fibrous adhesions. The left pleural cavity contained 2,000 cc. of clear straw-colored fluid and the pleural surfaces were smooth. The ribs and vertebrae were intact. The peribronchial lymph nodes were of average size and on section were gray with mottled black areas.

The right lung weighed 2,000 grams (Fig. 2). The upper and middle lobe fissures were partially obliterated and the middle lobe near the hilum was firmly bound to the adjacent upper lobe. The upper lobe was enlarged, firm and dark purple with black mottling. The upper and lateral surfaces were covered with thick fibrous tissue. The middle and lower lobes were small,

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hypocrepitant, flabby and had a dark purple surface with black mottling. On section, the upper lobe was replaced by a large spheroidal mass measuring 20 by 15 by 12 cm., which had a pearly white appearance with a soft, friable and dark red central portion. The periphery was limited by a rim of compressed lung, except over the posterior lateral aspect of the lobe where it was indistinguishable from the cover-

and are occasionally seen as large cells with two elongated nuclei (Fig. 5). Diffusely scattered among these stromal cells are many large giant cells (Fig. 6) with abundant acidophilic, finely

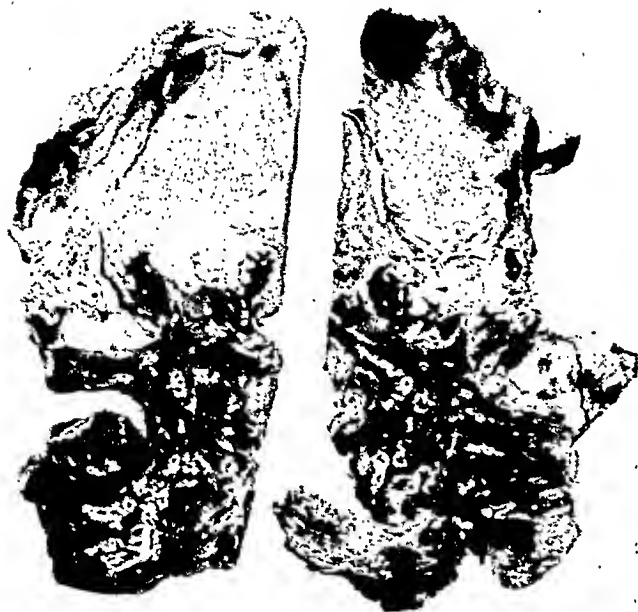


FIG. 2. Malignant variant of giant cell sarcoma of the lung.

ing fibrous tissue. Near the hilum this mass extended into the middle lobe. The cut surface of the middle and lower lobes was dark red. The left lung weighed 600 grams, and the surfaces were smooth and gray with fine black mottling. The consistency was hypocrepitant and on section the cut surfaces were deep red and exuded an excess amount of frothy, blood-tinged fluid. The bronchi of both lungs contained a frothy fluid and the mucosae were smooth and pink.

Microscopically, the parenchyma of the right upper lobe is compressed by a poorly circumscribed tumor composed of large fusiform cells (Fig. 3) arranged in a syncytium-like manner, the protoplasm of one cell blending into that of another. The cytoplasm is lightly acidophilic, finely granular, and contains occasional large clear vacuoles. The nuclei are large, irregularly oval and vesicular with prominent nucleoli. These cells vary markedly in size and shape (Fig. 4), are frequently seen in a state of mitoses

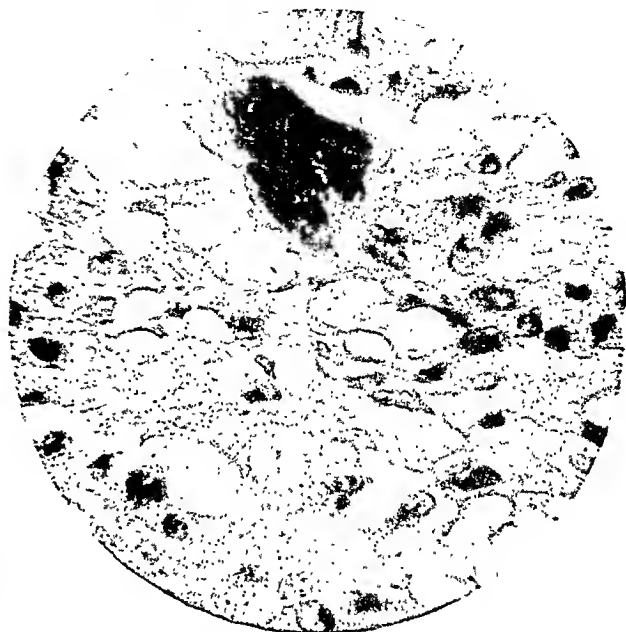


FIG. 3. Syncytium-like arrangement of vacuolated sarcoma cells with a multinucleated giant cell.

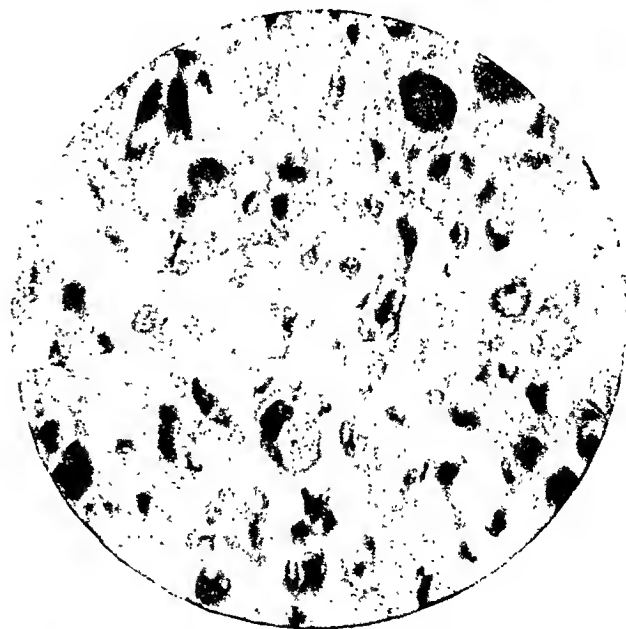


FIG. 4. Marked variation in the size and shape of cells with a hyperchromatism of the nuclei.

granular cytoplasm which has short processes and contains small vacuoles. The nuclei vary from 10 to 50 in number; they are round, vesicular, and have conspicuous nucleoli. Within the tumor are numerous thin-walled blood vessels. Within large areas of necrosis these vessels contain thrombi. Sections of a tracheo-



bronchial lymph node and rib are devoid of tumor.

The additional postmortem findings were tubular adenoma of the left kidney, myocardial fibrosis and hyperplasia of the bone marrow.

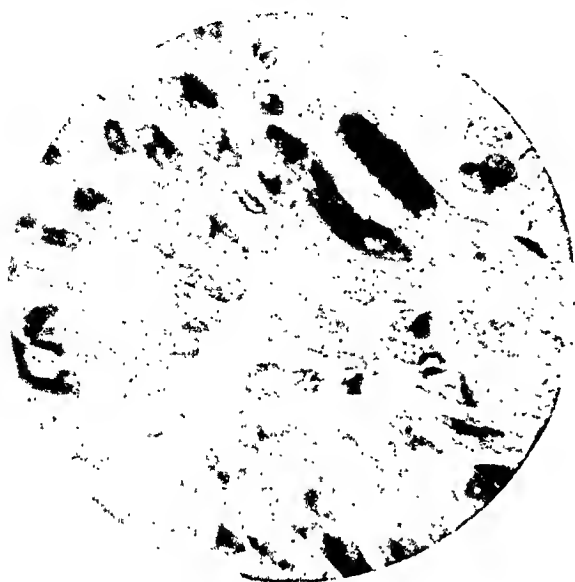


FIG. 5. Elongated giant spindle-shaped cells.

#### DISCUSSION AND CONCLUSIONS

It is difficult to feel certain that such a sarcoma, as has been presented, actually arose within the lung and was not merely a metastasis from an undisclosed minute skeletal tumor or direct extension from a primary intrathoracic neoplasm. However, this patient's entire osseous system was carefully roentgenographed before his death, and the only pathological change recorded was hypertrophic pulmonary osteoarthropathy. Postmortem examination of the mediastinal cavities, ribs, and vertebrae did not disclose any possible primary source. Furthermore, the tumor, *per se*, was a single mass limited to one lobe and separated from the thoracic cage by pleura or fibrous connective tissue.

The unusual feature of this neoplasm is its histopathological similarity to malignant giant cell tumor of bone. In these tumors, Stewart, Coley and Farrow<sup>1</sup> found

many giant cells with few nuclei and often large nucleoli. Between the giant cells were large fusiform, syncytium-like cells with rather clear cytoplasm and large nucleoli. Atypical mitoses were common. Evidence of bone or cartilage was not found. In their 7 cases occurring in bone, no instance of pulmonary metastases was noted. Jaffe, Lichtenstein and Portis<sup>2</sup> mention 2 instances of malignant transformation of giant cell tumor with pulmonary metastases, but the one lung lesion described microscopically in the case reports did not possess a giant cell structure.

Jaffe, Lichtenstein and Portis consider giant cell tumors of bone to arise from undifferentiated marrow mesenchyme. It is pos-

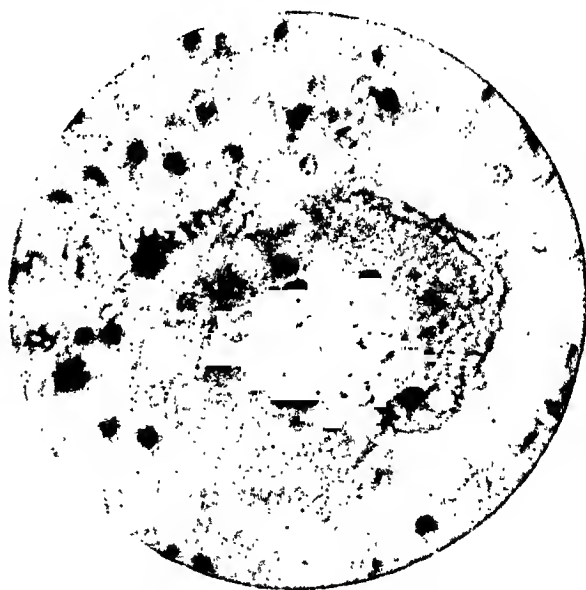


FIG. 6. High power field of a multinucleated giant cell.

sible that our giant cell tumor of the lung arose from pleural or interstitial pulmonary mesenchyme.

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# INTUSSUSCEPTION OF THE STOMACH

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**T**HIS case is presented because a thorough search of the literature revealed no adequate illustration depicting direct intussusception of the stomach.

This condition may be defined as the invagination or indigitation of a portion of the full thickness of the stomach into the

this condition in a case operated on for gastric neoplasm with no roentgen findings.

In 1926, Eliason, Pendergrass and Wright, and since then many others, have reported on benign tumors of the stomach associated with prolapse of the gastric mucosa. These were not cases of intussusception.

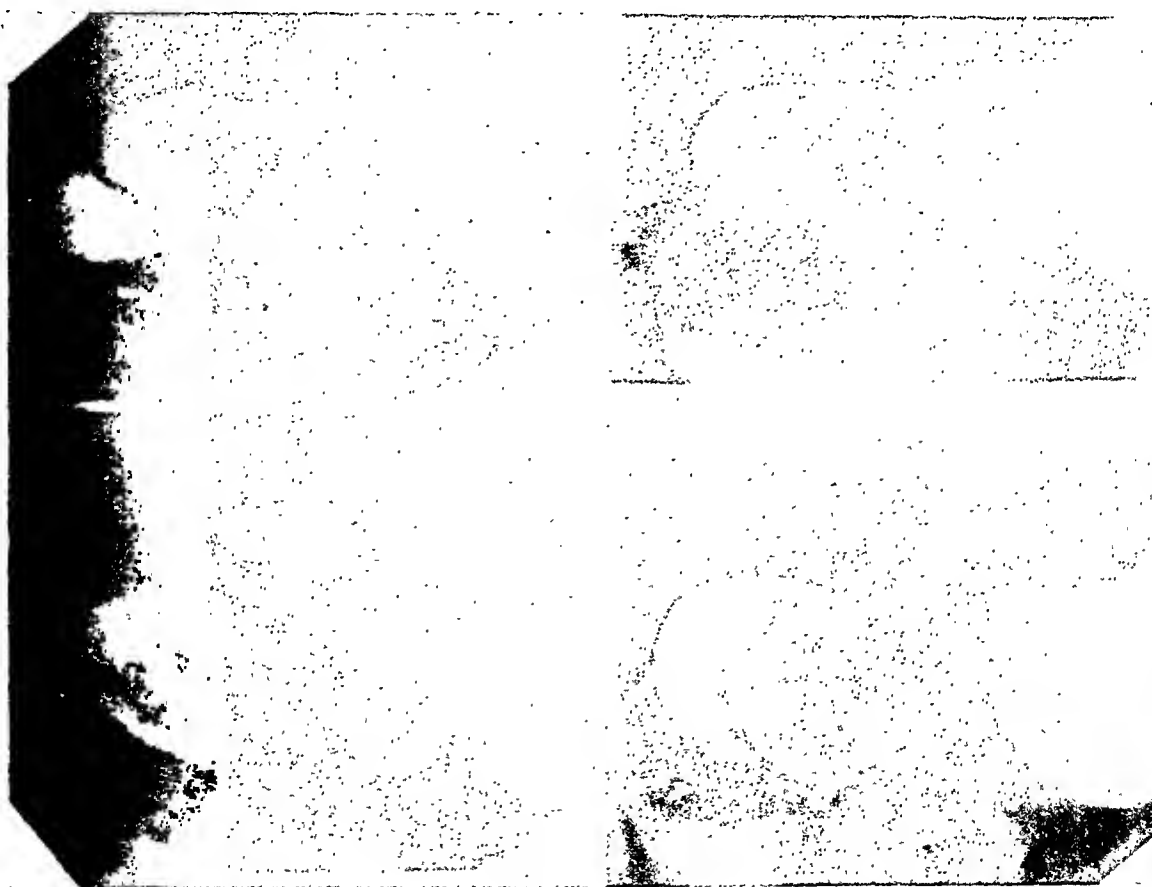


FIG. 1. Intussusception of stomach during attack of pain.

portion of the alimentary tract just distal. In retrograde or indirect intussusception, the lower full thickness segment is drawn up into the upper segment.

In contrast, prolapse of the gastric mucosa alone into the duodenum is not uncommon.

In 1913, Wade described the operative findings of a case in detail but had little to say about the roentgen diagnosis.

In 1922, Eusterman and Sentry reported

In 1933, Lönnerblad reported 2 cases of intussusception diagnosed roentgenographically.

The etiologic basis for simple prolapse is usually the presence of a mass, often a benign polyp, in the pylorus which prolapses through the sphincter causing traction on a portion of the gastric mucosa.

Theoretically, it is possible for such a mass to cause traction on the full thickness of the stomach offering a simple explana-

tion for intussusception in the presence of a pedunculated mass. There is, however, no adequate explanation in the absence of a mass except to explain it on the basis of some disturbance of the innervation, either spastic or paralytic.

The following case is an example of a spontaneous direct intussusception in the absence of any mass.

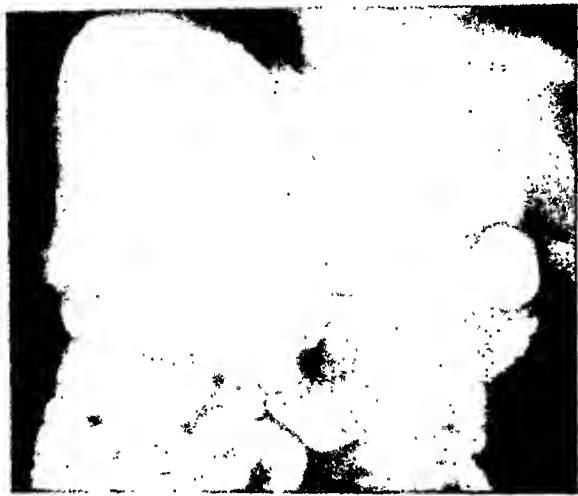


FIG. 2. Normal stomach and duodenum in the interval.

#### CASE REPORT

The patient, a white male, aged seventy-eight, was seized with an acute attack of continuous epigastric pain accompanied by nausea, vomiting, and hiccoughing. The epigastric region was tender but not rigid. There had been a similar two day episode six weeks previously.

The roentgen examination revealed:

1. That the distal half of the stomach was markedly narrowed, and the duodenum was markedly widened as far down as the lower part of the second portion.
2. That the widened duodenum acted as the intussusceptum, the narrowed portion of the stomach having telescoped or invaginated into the lumen of the widened duodenum.
3. That the intussusceptum reached the distal end of the dilated duodenum.

4. That the folds of the gastric mucous membrane were compressed in a horizontal direction and were seen within the surrounding concentrically arranged dilated duodenal mucous membrane folds.

5. That the emptying time of the stomach was greatly increased.

6. That spontaneous reduction occurred, at which time the stomach and duodenum were normal.



FIG. 3. Intussusception in a subsequent attack.

7. That subsequent roentgen examination during a later seizure again visualized the intussusception.

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## MILITARY PHOTOROENTGEN TECHNIQUE EMPLOYING OPTIMUM KILOVOLT (PEAK) PRINCIPLES\*

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*Sanitary Corps, Officers Reserve Corps*

THE practice of 4 by 5 inch photoroentgenography has encountered many difficulties during the period of its employment by the Armed Forces. The sudden and early demand for photoroentgenograms of the chests of inductees created a measure of consternation, for large volumes of work were precipitately thrust upon induction stations without an adequate opportunity to train personnel nor to crystallize a rational photoroentgenographic procedure. As personnel began to become experienced, a degree of standardization developed with some improvement in results, but it was largely only in direct proportion to the ingenuity and conscientiousness of personnel operating individual photoroentgen units.

An outstanding fault with photoroentgen techniques was the toll exacted in the form of damaged roentgen-ray tubes and wasted film. Obviously, the diagnostic value of the photoroentgenogram is in direct ratio to its technical quality; yet, the careless and often thoughtless attention given to its exposure and processing contributed greatly toward diagnostic inaccuracies.

Photoroentgenography is not entirely a roentgenographic procedure for although the fluorescent image of the chest is caused by the action of the roentgen rays, the *recording* of the image is distinctly a photographic process. The processing procedure necessarily must depart in some measure from the conventional one employed for roentgenograms since the film emulsion is primarily a photographic one. Lack of appreciation of these facts has been the reason for most failures to produce satisfactory results.

As evidenced by a survey of many induction station laboratories, a fixed standard

of technique was not habitually used. Exposures were based upon a variable kilovoltage-thickness of part technique and the variety of factors employed demonstrated lack of a systematized procedure which was in keeping with the poor results obtained. Considerable latitude in choice of factors was widely evidenced which was to be expected since no unanimity of opinion had been evinced that would lead to the production of photoroentgenograms of uniformly good quality.

A prevalent fault was the use of kilovoltages much too low to effect complete penetration of the chests of the average and large subjects; this resulted in loss of detail, particularly in the peripheral portions of the chest. In an attempt to produce a satisfactory image under these circumstances, higher and higher milliamperesecond values were employed coincident with excessive tube damage, without obtaining satisfactory results. Also, it was impossible to secure an image of satisfactory density when film development varied greatly and little or no control over the temperature was exercised. The proper type and quality of roentgen film developer employed was seldom considered. For example, the use of inadequate kilovoltage often necessitated the limiting of photoroentgenographic examination to those chests measuring less than 24-25 cm.; larger chests required roentgenographic examination on 14 by 17 inch roentgen film. Obviously, a limitation of this kind incurred the necessity for two examining procedures instead of one, as was originally intended.

Realizing the shortcomings of the technical factors normally employed in chest photoroentgenography, especially the kilo-

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voltage, some personnel began to employ higher kilovoltages with some measure of success, although the time of development of the roentgenogram was still *too short* to permit a proper image density to appear on the film. A disadvantage recognized, but tolerated, was the presence of abundant secondary radiation fog on the photoroentgenogram. This was corrected to some extent in some laboratories by the use of a grid, although the kilovoltages applied when employing this device were still not sufficiently high to produce a satisfactory image. On the other hand, applied milliamperes-second values often were increased to compensate unwittingly for lack of full development. The development times were still too short to permit adequate densities to be built up. The high milliamperes-second values *seemed* necessary to compensate for the loss in density; yet the kilovoltages employed were too low to produce a satisfactory image because of incomplete penetration of the chest. All these factors necessitated adjustment if results were to be diagnostically acceptable. The foregoing was the status of photoroentgenography when it was decided to apply the optimum kilovoltage technique theory in an effort to obtain more desirable results.

In the summer and fall of 1943, with the able technical assistance of Captain Philip McMahan, SnC, and the Technical Staff of the Armed Forces Induction Station, Baltimore, Maryland, experimental exposure data were secured which was based on the optimum kilovoltage theory of technique. The experimental techniques developed were used by selected photoroentgen laboratories in order to procure representative photoroentgenograms as made with varying degrees of technical aptitude. Based on the results obtained, a standardized technique was evolved that was simple to apply, reduced potential tube damage to a minimum and provided photoroentgenograms of limited variability as regards image densities. It was not deemed wise to effect total density uniformity in comparable areas, for the small differences in den-

sity, caused by variations in tissue radio-opacity, have pathological, physiological or anatomical significance and are, therefore, of diagnostic value.

Based on this preliminary work, a standardized exposure technique and processing procedure were employed in making an experimental survey of a representative group of inductees passing through an induction station. The quality of the photoroentgenograms secured in 1,111 cases was in keeping with the prior excellent experimental results obtained.

#### EXPOSURE TECHNIQUE

Briefly, the optimum kilovoltage theory of technique<sup>1</sup> is based on the premise that for every roentgenographic projection, when employing a standard mechanical and electrical setup, there is an *optimum* kilovoltage that will fully penetrate a given part with the production of a minimum of secondary radiation fog. Its use depends upon the classification of all body parts into three groups for purposes of facilitating the use of time factors in convenient multiples; and, a *standardized processing procedure*. For its application to photoroentgenography, a stationary grid is necessary.

*Apparatus.* A generator capable of delivering 100 kv. (peak) at 200 ma. should be employed for this technique. A stationary anode roentgen tube with a focal spot of 5.2 mm. is used, although a rotating anode tube may be used if desired. A blower attached to the tube is advisable although it is not entirely necessary for the heat generated by the sequence of exposures recommended is well within the safe heat capacity of most tubes.

A synchronous timer capable of providing exposures in tenths of seconds is necessary. Timers should be checked at frequent intervals for accuracy by spinning top tests to insure uniformity of exposure.

Some photoroentgen laboratories are

<sup>1</sup> Fuchs, A. W., Optimum kilovoltage technique in military roentgenography. *Am. J. Roentgenol. & Rad. Therapy*, 1945, 50, 147-153.

equipped with apparatus possessing a capacity of 85 kv. (peak) at 200 ma. Such generators may be satisfactorily altered by the manufacturer to deliver 150 ma. at 100 kv. (peak) by the addition of an auxiliary piece of equipment.

*Milliamperage.* It is unwise to operate present army photoroentgen apparatus at its capacity of 200 ma. for roentgen tube damage when employing stationary anode tubes is excessive under such circumstances. Operation at capacity or greater results in destroyed tubes after as low as 2,000 exposures and as high as 25,000 exposures. This life span is not considered unusual when using 200 ma. It was found, however, that when 150 ma. was employed, an immediate economy in tubes resulted; their life was extended in many instances to over 110,000 exposures. For this reason, a milliamperage of 150 was established as an invariable standard.

Damage to tubes is largely caused by milliamperage and *not* kilovoltage. Damage is related to the heat developed per unit area of focal spot and the rate at which it is applied. This must be common knowledge, yet the objective has been to use high milliamperages and lower and lower kilovoltages. Most damage to tubes is caused by overloaded focal spots wherein melting and cracking of the bombarded area results; a *single* overcapacity exposure is sufficient to irreparably damage a tube. Such damage cannot be attributed *per se* to general overheating or thermal overload because the quantity of copper in the anode of most tubes usually is adequate to dissipate the heat generated under normal working conditions. The increase in *roentgenographic efficiency* produced by the use of increased kilovoltage is obtained with a proportionately smaller amount of heat because of the use of a lower milliamperage. When the tube is operated below its rated capacity, damage to the focal spot is relatively nil even though high kilovoltage is employed.

*Kilovoltage.* The use of 100 kilovolts as a constant in chest photoroentgenography may seem radical at first glance. However,

certain desirable overall characteristics of the photoroentgen image must be considered. A maximum of image detail is procured only when the chest is fully penetrated. Since the penetration is controlled by the kilovoltage, 100 kv. (peak) was selected to penetrate any human chest. Obviously, such high kilovoltage will produce an abundance of secondary radiation. This is controlled or largely eliminated by the use of the stationary grid. Because of the reduction in the size of the image to one accommodated by the 4 by 5 inch film, grid lines are not normally visible.

The high kilovoltage provides *long scale* contrast so that all detail is visible yet the density is never excessive; the detail is visualized by means of a great number of small differences in density. This kilovoltage also provides such extreme exposure latitude that overexposure is impossible within the exposure limits cited in the technique chart to follow. The latitude also provides transparent images irrespective of the chest thickness; no areas of over- or under-exposure on the same image are visible. Silver is deposited in the greater portion of the chest image.

*Secondary Radiation Fog.* It was demonstrated by Sir Gabriel Stokes in 1852 that radiation striking substances capable of fluorescence caused visible light to be produced of a longer wavelength than the inciting radiation. For example, ultraviolet radiation, which is not visible, striking wilomite crystals will cause this substance to emit a yellow-green fluorescent light. Since this light is within the visible spectrum, its wavelength is obviously longer than that of the invisible, shorter wavelength ultraviolet radiation.

A comparable phenomenon also occurs when short wavelength r-radiation strikes an object such as human tissue. The tissue will emit secondary r-radiation with a longer wavelength than the inciting roentgen rays. Since the kilovoltage applied to the roentgen tube determines in large measure the wavelength of the emitted primary beam, the relative amount of secondary

radiation reaching a film may be roughly forecast.

The influence of kilovoltage upon production of secondary radiation fog on the roentgenogram is not generally understood. Roentgenograms made with low kilovoltage are usually recognized because of the relative *absence* of secondary radiation fog and by the *short* scale of its contrast. The primary beam of long wavelength roentgen rays produced with low kilovoltage incites secondary radiation within the part they penetrate. Since the wavelength of this radiation is longer than that of the primary beam, most of these rays are absorbed by the tissues and few ever reach the film emulsion.

The shorter wavelength secondary radiation produced by the higher kilovoltages have appreciably more penetrating power and are not all absorbed by the tissues which generate them. Many reach the film and if the kilovoltage is sufficiently great, then the roentgenogram shows unmistakable evidence of secondary radiation fog. This may be illustrated by making roentgenograms of the pelvis with and without a grid. The fog in the latter roentgenogram may be easily seen when compared with the former.

Agents that produce *supplemental* deposits of silver on the film, such as secondary radiation, affect the overall image density. Secondary radiation fog is roentgenographically unwelcome and unwanted; it must be eliminated or reduced to a minimum by every known means such as is provided by the use of grids, cones, etc. Secondary radiation is unfocussed, aberrant and is rampant from every direction. Because of its unfocussed nature and its wide source, it produces a density which is *supplemental* to that produced by the primary beam. The quantity of secondary radiation is dependent upon the applied wavelength of the roentgen rays which is governed by the kilovoltage used.

The exposure effect of secondary radiation should not be considered when formulating exposures for the primary beam. This

mistake is commonly made by technicians when kilovoltages instead of milliamperes-seconds are changed with a view toward controlling or adjusting roentgenographic *density*. But, decreasing or increasing the kilovoltage does have a noticeable effect upon the amount of secondary radiation fog generated.

Secondary radiation fog may be likened to an observer viewing an object through a window pane. If the pane is dirty, the object seems indistinct. However, if the pane is cleaned, the object becomes clearly and distinctly visualized. Cleaning the pane is analogous to the use of devices such as cones and grids that tend to eliminate or reduce the amount of secondary radiation reaching the film and thereby clearing the roentgenogram of objectionable secondary radiation fog.

*Tube Position.* The long axis of the roentgen tube should be vertical in photoroentgenography and the cathode end of the tube should be uppermost. This makes it possible to take advantage of the "heel effect" of the anode in balancing roentgenographic densities. In this position, the greatest quantity of roentgen rays is directed toward the upper thorax where the greatest tissue density usually exists. Also, better dissipation of heat from the tube is effected for the oil heated by the anode rises, causing more efficient circulation.

The vertically placed tube must be centered properly for the relatively short standardized anode-screen distance of 36 inches may cause cutoff of the image when stereoscopic exposures are made. The tube should be centered, then the tube moved to the No. 1 stereoscopic position; after the first exposure is made, the tube is shifted to the No. 2 stereoscopic position. The No. 1 stereo-shift tube position should not be employed for centering. Furthermore, a total stereo-shift of 3 inches is adequate.

*Exposure.* All adult chests are classified in three groups—first, second, and third. The first group requires 0.2 sec. exposure; the second, 0.3 sec. exposure; and, the third, 0.4 sec. exposure. A fourth group requires



14 by 17 inch roentgenography. Since the percentage of these cases is very small, there is no reason to cause possible overheating of the focal spot in an attempt to make photoroentgenograms employing an exposure greater than 0.4 sec.

*Rate of Operation.* The rate of operation

utes with 10 minutes rest per hour. Based on an eight hour day, 400 cases can easily be examined. The objective should be to maintain a steady rate of patient flow which helps to minimize personnel fatigue, assures superior technical results, and avoids excessive heating of the tube.

TABLE I

PHOTOROENTGEN TECHNIQUE OF CHEST

PROJECTION	POSTEROANTERIOR
PREPARATION OF PATIENT	Remove clothing and radiopaque material from area; if female, drape with cotton or paper cape.
LOCALIZATION POINT	Point over 6th thoracic vertebra placed opposite center of camera front.
POSTURE	Patient erect; toes placed on line 6" anterior to face of camera; anterior aspect of thorax against front of camera so that 6th thoracic vertebra is opposite center of front of camera; chin extended and rests on chin-rest; hands on hips with thumbs directed anteriorly until shoulders touch face of camera. Median plane is coincident with long center axis of camera face.
RESPIRATION	Respiration suspended on <i>full</i> inspiration. If respiration is not carefully controlled, underexposure or blurring of image is apt to occur or there is insufficient pulmonary aeration.
TUBE ALIGNMENT	Long axis of tube is coincident with median plane (vertical). Cathode portion of roentgen-ray beam directed <i>cephalad</i> when pectoral girdle is well developed; <i>caudad</i> , when overdevelopment of the lower thorax or pendulous breasts are present.
PROJECTION CENTRAL RAY	Central ray projected in median plane perpendicularly to center of camera face through 6th thoracic vertebra.
STEREOROENTGENOGRAPHY	Stereo. No. 1: 1½" shift, cephalad from centering point; stereo. No. 2: 1½" shift, caudad from centering point.

PHOTOROENTGENOGRAPHIC FACTORS

CONSTANT FACTORS

Kv. (peak)	100
Ma.	150
Distance	36"
Stationary grid	

VARIABLE FACTORS

Thickness	Time
17-24 cm.	0.2 sec.
25-27 cm.	0.3 sec.
28-32 cm.	0.4 sec.
33-	Use 14" X 17" roentgenography

should be one stereoscopic pair per minute. This rate may *appear* to be slow, but if the patient is properly posed, and instructed as to respiration, the amount of time allotted will not be found too great in many instances. There is sometimes a tendency among personnel, as a matter of competition, to see how many cases can be handled in a given time. This leads to careless posing of the patient and does not permit temporary cessation of respiration.

Operation should take place for 50 min-

*Positioning.* Positioning of the chest before the photoroentgen camera is important so that comparable anatomical areas are projected on the film. Rotation of the patient's trunk should be avoided. Respiration should be carefully controlled. Be sure you do not "rattle" the patient when giving him instructions. Details of posing, etc., are contained in Table I.

ANALYSIS OF TECHNIQUE

For the convenience of photoroentgen

exposures, all chests are divided into three primary groups, since all technical factors except time are constant. The first group includes those chests measuring 17-24 cm.; the second comprises the 25-27 cm. group; and the third, 28-32 cm. In some cases a fourth group would consist of chests 33 cm. and greater in thickness which should require 14 by 17 inch roentgenography in the interest of tube conservation.

chests which were photoroentgenographed is charted in Table II.

Note that in Table II the first group is the largest and 0.2 sec. stereoscopic exposures were employed for 67.3 per cent of the cases; in the second group, 0.3 sec. exposures were employed for approximately 30.5 per cent of the cases, and in the third group, only 2.2 per cent required 0.4 sec. exposures. As a precautionary measure, a

TABLE II

Thickness Group	Posteranterior Thickness cm.	Number Chests Examined	Percentage of Each Thickness	Group Percentage of Total	Exposure
First	18	2	0.2	67.3	0.2 sec.
	19	11	1.0		
	20	20	1.8		
	21	88	7.9		
	22	177	15.9		
	23	227	20.4		
	24	223	20.1		
Second	25	169	15.2	30.5	0.3 sec.
	26	118	10.6		
	27	52	4.7		
Third	28	20	1.8	2.2	0.4 sec.
	29	3	0.3		
	30	0	0.0		
	31	1	0.1		
Total		1111	100.0	100.0	

An analysis of each of the first three groups in an experimental survey of 1,111 cases showed that all images were transparent and the densities within the areas of the great vessels and heart were comparable. The lateral borders of the bony thorax were, in most instances, clearly defined due to the complete penetration of the chest and the *long scale* of contrast provided by the high kilovoltage. All photoroentgenograms were examined by roentgenologists and were declared to be diagnostic.

A typical sampling of the results to be obtained employing this technique may be cited as an example. No photoroentgenogram was discarded because of technical fault. The statistical analysis of 1,111

three minute interval was permitted to elapse between each pair of 0.4 sec. stereoscopic exposures.

One exception to the above standardized technique should be made. Certain chests in the first and second groups were found to be wide and the posteroanterior thickness from a roentgen-ray absorption standpoint was greater than the group in which they were placed according to actual measurement. Photoroentgenographic images of wide chests are often cut off at the edges of films. These chests are usually shallow in posteroanterior thickness, the average proportionate relationship between flesh, bone and air-bearing tissue is upset and less air-bearing tissue is present. This condition re-

sults in slight peripheral underexposure of the film if the normal exposure is given. Wide chests, therefore, require an additional 0.1 sec. exposure plus the exposure time assigned to the group. It was also found that any photoroentgenogram which showed insufficient density in the first and second groups, although perfectly diagnostic, could be given a more desirable density on a retake by repeating the exposure plus 0.1 sec. Arbitrarily, the technician should increase the exposure in all

in the posterior portion of the thorax to be somewhat diffused in the posteroanterior view because of the long part-screen distance. In such cases, a stereoscopic anteroposterior view is of value. These views may be made simply by employing the same exposure factors used for the posteroanterior view plus 0.1 sec. exposure added to the basic time applied in the thickness group to which the case belongs. In other words, if a posteroanterior view of a 23 cm. chest is made employing 0.2 sec. exposure, the

TABLE III  
TECHNICAL FACTORS FOR 14 BY 17 INCH CHEST ROENTGENOGRAPHY

Optimum kv. (peak).....80  
Distance.....72"      Screens.....medium speed  
Development.....3 min. at 68° F. in *Kodalk* developer

Patient Class	Thickness Range, cm.	Ma.	Time sec.	Ma-sec.	Ma.	Time sec.	Ma-sec.	Ma.	Time sec.	Ma-sec.
Small	-19	30	1/10	3	50	1/15	3 1/3	75	1/20	3.75
					100	1/30	3 1/3	150	1/40	3.75
Average	20-27	30	2/10	6	100	1/15	6 2/3	150	1/20	7.5
Large	28-	30	4/10	12	100	2/15	13 1/3	150	1/10	15.0

cases of wide chests. In any case where the exposure yields a photoroentgenogram of slightly less than desirable density, the exposure should be increased by 0.1 sec. Maximum exposure in any case should never exceed 0.4 sec. in the interest of tube conservation.

The fourth group comprises chests 33 cm. and greater in thickness and should require the use of 14 by 17 inch roentgenography. The percentage of such cases is considerably less than 1 per cent and photoroentgenography is not justified from the standpoint of tube conservation. Photoroentgenography can be employed if found necessary, simply by increasing the time of exposure in excess of 0.4 sec., although it is not recommended with the tubes now available.

*Anteroposterior Views.* The relatively short anode-screen distance of 36 inches may at times cause the image of structures

anteroposterior view of the same chest would require 0.3 sec. exposure.

*14 by 17 inch Roentgenography.* When 14 by 17 inch roentgenography is required, the following technical factors based on the optimum kilovoltage technique should be employed. Since the conditions of roentgenography of the chest are quite different from those of photoroentgenography, the thickness groups and kilovoltage employed must be changed as well as the time of film development. The posture assumed by the patient and arrangement of apparatus is approximately as described in the technique summary for posteroanterior photoroentgenography. The following technical factors (Table III) will provide images of consistently comparable densities. Exposure times are such that either synchronous or impulse timers may be employed; a selection of milliamperages will permit the employment of various types of apparatus.

PROCESSING PROCEDURE

Photoroentgenography entails the use of expensive apparatus. Irrespective of the care with which exposure factors are chosen or the patient posed and respiration controlled, the diagnostic quality of the photo-roentgenogram secured is dependent upon the manner in which it is *processed*.

It must be realized that photoroentgenograms do not serve a transient purpose.

the image-density, there must be an adequate concentration of silver to obtain a substantial image of the *whole* chest. It is therefore necessary to develop the film in conformity with a standardized procedure in order to obtain the maximum density with freedom from fog. Unless the technician realizes these facts, there is no point in making the exposure for the results will not be worth the effort involved.

TABLE IV

Exhaustion Period	Time of Development	Number of Films (4"×10") Developed in Tanks of Varying Capacity			
	68° F.	6 gal.	10 gal.	15 gal.	20 gal.
A	8 min.	637	1125	1767	2468
B	9 min.	292	518	809	1130
C	10 min.	214	375	589	821

One 14"×17" film is equivalent in area to six 4"×10" films.

They constitute records which are of extreme value to the Government or other agency, not only at the time they are made, but also years hence. It is urged that a standardized processing procedure be employed so that the basic objectives of photoroentgenography may be served now, as well as in the future.

Film (4 by 10 inch) employed for photoroentgenography is single coated, and the emulsion is most sensitive to the blue-violet light emitted by the fluoroscopic screen mounted in the photoroentgen camera. The photographic characteristics of the film are such that longer development must be employed than that normally given to roentgen film if a satisfactory image is to be secured.

The purpose of exposure is to sensitize the emulsion so that upon development the silver bromide will be capable of change to black metallic silver. The longer the period of development—up to a certain point—the more silver is deposited. Since the black metallic silver constitutes what is known as

A *standardized time-temperature* method of development must be employed if the photoroentgenograms are to possess uniform quality. Variation in time of development produces variations in image-density which influence the customary diagnostic appearance of the photoroentgenograms. When the processing procedure is essentially a constant and the exposure technique is standardized, variations in density may then be attributed to anatomical or pathological peculiarities of tissue.

*Development.* Photoroentgen film requires eight minutes' development at a temperature of 68° F. in fresh Kodalk x-ray developer. To insure complete development of the film to a standard density, the rate of exhaustion of the developer must be noted. By recording the number of films passed through the solution, compensation for the decrease in developer action must be made by changing the development time.

The time of development and the number of 4 by 10 inch films to be processed for given periods of exhaustion in given

quantities of solution are listed in Table iv. At the end of the "C" period, the developer is to be discarded and new solution placed in the tank. The fixing bath is also to be changed at the same time.

When the temperature of the solution changes, the development time must also change in order to maintain a standard density. The following time-temperature table should be employed to effect the proper change (Table v):

TABLE V

Temperature	Exhaustion Period Minutes		
	A	B	C
64° F.	9½	10½	12
66° F.	8½	9½	11
68° F.	8	9	10
70° F.	7½	8½	9
72° F.	6½	7½	8

*Fixation.* The purposes of the fixation of the photoroentgenograms are (1) to remove the unexposed silver bromide crystals from the film, thereby clearing it, and (2), to thoroughly harden the emulsion to facilitate drying.

Hardening of the film is dependent upon the use of a reasonably active fixing bath. If exhausted fixing baths are used, hardening of the film is diminished or entirely eliminated and the emulsion will remain swollen with solution. Melting of the emulsion may occur in the wash water or a prolonged drying time results.

To insure procurement of well hardened and shrunken emulsions, the quantity of fixing bath should be equal to 1½ times, or twice that of the developer. And, each time the developer is changed, the fixing bath should be changed. This procedure will make possible fast drying of films and eliminate many other troubles that are encountered with hot weather film processing.

*Drying.* Adequate film drying facilities are usually available in most laboratories, but film drying frequently is a problem that is still not given sufficient consideration. If the films are placed in the dryer with swollen emulsions, they will not dry rapidly, particularly when the atmospheric humidity of the room is high. Delayed drying is often attributable to recirculation of moisture laden air in the darkroom, the relative humidity being higher than that of the outside atmosphere. When emulsions are adequately hardened, the drying rate is fairly rapid; whereas if the humidity is high, the drying rate is unduly prolonged. Elimination of moisture laden air may be obtained by venting all film dryers to the outside.

When exposed films are placed in developing hangers, they should not be stacked directly under the safelight unless they are shielded. Exposed films are always more sensitive to exposure to the light from safelights than are unexposed films.

CONCLUSIONS

It has been proved that the photoroentgen technique as described has been found, in the many laboratories employing it, to be economical in time, use of materials and apparatus, and strain on the part of operating personnel. Its simplicity of operation and the high quality of results has served to promote greater diagnostic accuracy.

Where large numbers of individuals are to be surveyed, total reliance upon the judgment of operating personnel for exposure estimation is open to considerable error. The use of preformulated or standardized factors, as described in this paper, will assure a greater percentage of successful results than any other method now being used.

It will aid the technician to remember that in the optimum kilovoltage technique, the kilovoltage applied regulates the scale of contrast, production of secondary radiation and subject penetration; the milliamperere-seconds control image-density.

The experienced technician soon learns to evaluate the patient quickly, mentally placing him in the required exposure group without the necessity for measurement. Small errors in estimating thickness have no significance for the kilovoltage employed will always penetrate the chest. The exposure determines the image-density.

The Morgan automatic exposure timer, employed with the optimum kilovoltage technique described, has made possible almost total uniformity in the film-densities obtained. This timer tends, however, to produce approximately the same image-density on each film. If the roentgenologist is willing to waive the small differences in density that have diagnostic significance

from an anatomical, physiological, or pathological standpoint, then this timer will operate to produce density uniformity. The timer obviates measuring the patient.

If one were to prognosticate the future of photoroentgenography, developments will undoubtedly proceed along the lines of improvement in apparatus. Automatic cameras employing roll film, perhaps  $2\frac{1}{2}$  inches or 70mm. in width, and automatic processing will do much to solve present day difficulties. The increase in speed of lens and fluorescent screen seems to be the necessity at the moment. The greater speed of lens and screen will make possible the use of smaller focal spot tubes and greater anode-screen distances.



# ROENTGEN THERAPY FOR ACUTE ENCEPHALITIS\*

By U. V. PORTMANN, M.D., and ROGER LOUGH, M.D.

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FROM 1937 to 1942, 49 patients with acute encephalitis were treated with roentgen rays at the Cleveland Clinic; 29 patients recovered, 15 improved, 1 died, and 4 patients had no follow-up. The results were sufficiently encouraging to merit evaluation of the effectiveness of roentgen therapy as a method of treatment.

Specific viruses were recognized as causal agents in certain types of encephalitis after investigations of a peculiar infectious disease of the central nervous system which was epidemic in Rumania and France in the winter and spring of 1916-1917. A series of these cases was reported by von Economo,<sup>3</sup> and the disease was given the descriptive name "encephalitis lethargica." A somewhat similar epidemic appeared in the summer in Australia and was called "Australian X." Seven years later a severe epidemic of encephalitis occurred during the summer in Japan. Kaneko and Aoki,<sup>1</sup> investigating the epidemic, called attention to differences between winter and summer types of encephalitis, not only in seasonal incidence but also in certain clinical characteristics, and suggested that the winter form be called "Type A" and the summer form "Type B."

In the United States the first epidemic recognized as a specific virus type of encephalitis, the Japanese Type B, occurred in Paris, Illinois in the summer of 1933. A year later it appeared in St. Louis and elsewhere in the midwest. In 1938 encephalitis occurred epidemically east of the Appalachian Mountains and was especially severe in Massachusetts. This eastern type differed somewhat from the western in incidence, symptomatology, and mortality.

Both eastern and western types of encephalomyelitis have been recognized in animals and have been called "equine

encephalitis" in horses and "louping ill" in sheep. Persons caring for animals with these diseases have contracted encephalitis.

In addition, encephalitis may be a sequel to measles, mumps, whooping cough, influenza, and vaccination against smallpox, with no definite seasonal incidence. Encephalitis or encephalomyelitis may also result from bacterial infections, syphilis, or poisoning from chemicals.

The different types of encephalitis vary considerably in mortality and morbidity. The mortality averaged approximately 30 per cent in several epidemics of the winter type, encephalitis lethargica, and 25 per cent of the survivors eventually developed parkinsonism. In the summer type, Type B or the St. Louis type, the mortality averaged about 20 per cent. Parkinsonism is not a sequel to this type. In the eastern or equine types the mortality has been as high as 60 per cent, and in a majority of survivors the central nervous system is severely damaged. Information is meager concerning the mortality and morbidity of encephalitis following other infectious diseases, but probably the mortality rate is relatively low.

The pathologic features of virus encephalitis vary according to the type, duration, and intensity of the disease. Each type is said to have characteristic pathologic features, but certain changes are common to all. Virus encephalitis is a non-purulent inflammation of the brain and its coverings. In the acute stages there are varying degrees of hyperemia, hemorrhagic reactions, cellular infiltration, especially of lymphocytes, and proliferation of glia cells. In later stages various degenerative changes develop in blood vessels, nerve tissue, and meninges. These changes occur in scattered areas in the brain and its coverings and

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according to their location and extent cause a diversity of symptoms and signs. For this reason no symptom or sign is pathognomonic of any type of encephalitis.

Diseases of the central nervous system which clinically resemble encephalitis and must be considered in the differential diagnosis are lymphocytic choriomeningitis, early disseminated encephalomyelitis, acute multiple sclerosis, spontaneous subarachnoid hemorrhage, subdural hematoma, brain tumor or abscess, atypical types of meningitis, and poliomyelitis.

A great many drugs have been employed in the treatment of acute and chronic encephalitis and encephalomyelitis without significant success. Very few reports about the value of roentgen therapy have been made. Nuvoli<sup>13</sup> in 1929 reported 18 cases treated in acute stages with good results in 11 observed for five years. He used rather high dosages, converging the irradiation through five 4 by 4 cm. fields to the mesencephalon. Apparently reactions were severe. In the same year von Wieser<sup>19</sup> reported benefits in 4 cases of acute encephalitis. In 1930 Trautmann and Pansdorf<sup>17</sup> reported no significant improvement from roentgen therapy for chronic encephalitis (Parkinson's disease). Also in 1930 Revello and Vallebona<sup>14</sup> discussed the difficulty of interpreting the results of roentgen therapy for acute encephalitis because spontaneous recovery occurs in many untreated cases. They were probably the first to produce bacterial encephalitis in rabbits by intracranial inoculations with the tubercle bacillus and *Staphylococcus albus*. They noted that heavy irradiation to the heads of the animals immediately reduced the inflammatory reactions caused by the inoculations but increased hemorrhagic reactions. They concluded that patients with encephalitis should be treated cautiously because of the possibility of hemorrhagic reaction; however, this condition in their animals may have been the result of inflammation caused by the infection.

In 1931 Kohlmann<sup>8</sup> reported good results from roentgen therapy in poliomyelitis and

encephalitis. In 1932 Krause<sup>9</sup> reported 48 cases of acute and chronic encephalitis in which medical treatment was tried in some and roentgen therapy was given in others because (1) medical treatment had not been beneficial, and (2) the principal histologic change associated with acute encephalitis is radiosensitive round cell infiltration, the irritation of which produces young glia cells, which are also radiosensitive. Thirteen patients given light doses of roentgen therapy to the head at intervals of three or four days had symptomatic relief. Also in 1932 Lange and Schneider<sup>10</sup> reported that cases of chronic encephalitis were not benefited by roentgen therapy. They mentioned that Margolin as well as Engert and Hoff had attributed slight improvements to psychic effects in some cases of chronic encephalitis.

In 1934 Kiss and Szirmák<sup>7</sup> reported 8 cases of postencephalitic parkinsonism given moderate irradiation to the spinal sympathetic ganglia; 6 patients were so improved that they were able to return to work. Also in 1934 Goldberg, Baker and Hurff<sup>5</sup> described the essential lesions of encephalitis lethargica as a perivascular mantling of round cells, symptoms being caused primarily by pressure or circulatory disturbances. They concluded that rapid absorption of lymphocytes after irradiation relieved pressure and was responsible for the immediate alleviation of symptoms in 3 cases. They suggested that roentgen therapy might be beneficial for poliomyelitis and Landry's paralysis since the lesions of these diseases were similar to those of encephalitis.

In 1935 Goldberg, Brodie and Stanley<sup>6</sup> reported on experiments with the St. Louis strain of virus. From experiments with mice inoculated intranasally and then given irradiation, they concluded that roentgen therapy may either prevent or cure encephalitis. A report was made that year by Tachibana and Hasuo<sup>16</sup> on the results of roentgen therapy in Type B epidemic encephalitis; 5 of 11 patients reacted favorably. In writing about roentgen therapy for

diseases of the nervous system in 1936, Marburg and Sgalitzer<sup>11</sup> mentioned benefits in the treatment of encephalitis.

In reporting a series of animal experiments in 1937, Moore and Kersten<sup>12</sup> concluded that the St. Louis type of encephalitis virus "is inactivated by means of x-rays." Goldberg<sup>4</sup> published another article about benefits of roentgen therapy for encephalitis on the basis of experimental observations made previously. Also in 1937 Tucker<sup>13</sup> reported good results from the treatment of encephalitis by roentgen therapy and typhoid shock therapy. The cases he presented are included in this report. In 1937 von der Brück<sup>2</sup> advocated roentgen therapy of the brain stem for chronic encephalitis, but his results were not convincing.

Rubinfeld and Wolf<sup>15</sup> in 1939 reported 7 cases of chronic encephalitis not benefited by roentgen therapy and 2 cases of acute encephalitis which were improved.

Of the 70 cases diagnosed encephalitis at the Cleveland Clinic between 1937 and 1940, 21 cases were subsequently proved to be diagnosed incorrectly. In the remaining 49 cases of acute encephalitis the results of roentgen therapy seemed worthy of investigation.

Examination and laboratory studies included clinical and neurologic examinations, routine urinalysis, blood counts, serologic tests, and special studies of the cerebrospinal fluid. The spinal fluid pressure and the total protein, globulin, and cell counts were increased in about one-half the cases; in the remaining cases the diagnosis was based upon clinical and neurologic examinations. Normal spinal fluid findings do not necessarily refute a diagnosis of encephalitis. At one time or in any one case the spinal fluid may be normal and at another time or in another case may be pathologic, probably depending upon the stage, focus, and intensity of the infection. Cultures of the blood and spinal fluid were not made routinely. They give no additional information in the virus type of encephalitis but are of considerable value

in differentiating it and other bacterial inflammations of the central nervous system.

The most common symptoms in this series were low grade fever, headache, nausea or vomiting, vertigo, somnolence, and cranial nerve palsies causing ocular disturbances (diplopia) and speech disturbances (aphasia). Some seriously ill patients were in coma or had convulsions, monoplegia, or hemiplegia. No single patient had all these symptoms and signs, but each had different combinations of them in varying degrees.

#### TECHNIQUE OF ROENTGEN THERAPY

All cases were treated as other inflammatory processes might be treated, and the technical factors were substantially the same in every case (200 kv., 25 ma., focal skin distance, 50 cm., filter equivalent to half-value layer 0.8 mm. Cu, fields 15 by 15 cm.). The average skin dose was 75 to 100 roentgens to each side of the head, including the base of the skull, given daily or on alternate days, usually for a total of 300 r or less. The spine was treated in a few cases with evidence of cephalomyelitis. These comparatively small doses and one course of treatment seemed sufficient, though a few patients had a second course. Temporary partial epilation followed treatment occasionally, especially if dosages up to 400 r were necessary, but no other sequelae of importance were observed.

#### RESULTS

Lack of average response clinically in patients given roentgen therapy on the basis of an initial diagnosis of encephalitis suggested the probability that the diagnosis was incorrect. However, patients with an initial diagnosis of encephalitis were given roentgen therapy because many that did have encephalitis recovered promptly with early treatment and because treatment could not be harmful even though the diagnosis subsequently proved incorrect. Table 1 shows the diseases for which roentgen therapy was given on the basis of an incorrect initial diagnosis.

TABLE I  
INITIAL DIAGNOSIS INCORRECT

	Cases
Tuberculous meningitis	3
Brain tumor	7
Brain abscess	1
Subdural hematoma	1
Early disseminated sclerosis	1
Acute syphilitic encephalomyelitis	1
Lymphocytic choriomeningitis	1
Undulant fever encephalomyelitis	1
Diabetic coma	1
Hysteria	4
TOTAL	21

The diagnosis of encephalitis proved to be correct in 49 patients given roentgen therapy on the basis of history, clinical examination, laboratory findings, and clinical course. None was considered to have any type of epidemic encephalitis. A small number had a definite history of previous infectious disease such as influenza or measles, but others had had no recent acute illness, so that the etiology in these cases was unknown. No patient had a positive Wassermann reaction. The spinal fluid showed increase in pressure, cell count (lymphocytes), globulin, and total protein in 26 cases (53 per cent). As previously stated, normal spinal fluid does not refute the diagnosis of encephalitis, although pathologic findings may be confirmatory. Table II shows the results of roentgen therapy in relation to the spinal fluid findings.

TABLE II  
RESULTS OF ROENTGEN THERAPY FOR  
ACUTE ENCEPHALITIS

	Total Cases	Spinal Fluid	
		Pathologic	Normal
Recovered	29	15	14
Improved	15	7	8
Died	1	1	0
No follow-up	4	3	1
TOTAL	49	26	23

The 29 patients reported "recovered" are those that the referring clinicians considered benefited by roentgen therapy, be-

cause the course of the disease was shortened, and the patient had no residual symptoms or signs of disease of the central nervous system.

COMMENT

Some patients with encephalitis recover spontaneously. However, roentgen therapy produced an immediate and dramatic relief of symptoms and signs in many of our patients. Improvement began within two or three days, and most patients were discharged in about two weeks, though kept under observation. Because of normal cerebrospinal fluid findings in one-half the 29 patients who recovered, the question arises whether they might have recovered spontaneously. This seems unlikely because the spinal fluid was normal in other patients who did not recover but only improved. The spinal fluid was pathologic in the other half of the patients who recovered. This might indicate that they had more severe or extensive inflammation which might have caused permanent degenerative changes resulting in residual symptoms and signs if roentgen therapy had not been given. This explanation is plausible in view of the results in "improved" cases. Also it was quite apparent that patients treated in early stages of encephalitis recovered more promptly than those treated in later stages.

Fifteen patients were considered "improved"; they were relieved of some symptoms and signs of encephalitis by roentgen therapy but had evidence of permanent damage to the central nervous system. Half of these patients also had normal spinal fluid when first examined.

Two patients having normal spinal fluid initially had pathologic findings on subsequent examinations. When the spinal fluid was pathologic upon first examination, it continued to be so for several weeks or months, even though signs and symptoms improved.

In addition to roentgen therapy 5 of the patients who improved received injections of typhoid vaccine as reported by Tucker<sup>18</sup>

to "shake up the cells of the body and thus attenuate or destroy the virus." Two patients had typhoid shock injections before roentgen therapy, one during the course of treatment, another one month later, and a fourth one year later. It cannot be said that improvement was greater in these cases than in those given roentgen therapy alone, except possibly in 1 case. Tucker stated his conclusions, "Of the two methods, the best results follow radiation."

One of our patients died of encephalitis two years after treatment. Four patients are not available for follow-up: 1 left the hospital against advice before completion of treatment, and the results in 3 others are unknown.

Although none of the patients in this series was known to have epidemic encephalitis, some improvement from roentgen therapy might be expected in this type of disease. This is substantiated by the experiments of Goldberg, Brodie and Stanley and of Moore and Kersten, by the nature of the pathologic changes due to inflammation with which radiosensitive lymphocytic infiltration is associated, and by our experience and that of others in the treatment of somewhat similar types of encephalitis.

#### SUMMARY

The results of roentgen therapy in 49 cases of acute encephalitis were beneficial in a sufficiently large percentage to be encouraging; 59.1 per cent were considered recovered and 30.6 per cent improved.

The best results were obtained when roentgen therapy was given before degenerative changes were established in the central nervous system. No patient with a chronic form of encephalitis or with a post-encephalitic syndrome such as Parkinson's disease was definitely benefited by irradiation.

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#### DISCUSSION

DR. HENRY J. ULLMANN, Santa Barbara, Calif. When I was asked to open this discussion in the absence of Dr. Jenkinson, I felt very much as I did some years ago when I was asked to take the subject of supervoltage and its possible effects on tumors, at the meeting of the American Association for the Advancement of Science, at Pasadena, where the first million volt tube had just been installed. I knew nothing about it.

One would expect beneficial effects of irradiation on almost any inflammatory reaction. My experience with this condition has been with the postencephalitis syndrome, not parkinsonism. One patient, whom I remember very well, had attacks of vertigo and headaches which were steadily increasing. These came on some months after her encephalitis, and when it was thought that she was well and able to return to her work as a nurse technician. She became practically incapacitated from these attacks. She was treated almost exactly as Dr. Portmann has described, with complete relief, and it is now over four years since her treatment. She is entirely free from symptoms and working hard.

One would expect beneficial effects in any inflammatory reaction because of the known effect of irradiation on such conditions. Roentgen irradiation reduces hyperemia and reduces or

inhibits the formation of allergens, and while it also inhibits or reduces the formation of antibodies, it also prevents their destruction or excretion if once formed.

I bring this up as a warning, for if we are going to use irradiation in conjunction with antigens, the antigens must be given first; that is, the antibodies must be allowed to form before the irradiation is given. I should like to ask Dr. Portmann how early in the attacks he has given his irradiation, and also how late. I should also like to know if any of Dr. Portmann's patients had received any of the sulfonamides before the irradiation was given, because today, even in virus infections, somebody always fills the patients full of these drugs. One must expect that.

I was particularly anxious to hear this paper because we will probably have more encephalitis cases and because it confirms my feeling that irradiation can be used much more extensively than it has been in almost any inflammatory condition.

DR. PORTMANN (closing). I want to thank Dr. Ullmann for his extemporaneous discussion of this paper.

The question was asked in what stage of the disease the patients were when treated. Most of them had had evidences of encephalitis for two weeks and some for as long as two months. We considered them to be in the acute or subacute stages. After degenerative changes have taken place in the central nervous system, I doubt that irradiation will be beneficial, but it might stop the progress of the disease.

The question was asked about the use of sulfa drugs. These drugs were not administered to our patients during or after irradiation, though it is possible that some patients received them prior to admission to our hospital.



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*President:* William E. Costolow, Los Angeles, Calif.; *President-Elect:* Charles L. Martin, Dallas, Texas; *1st Vice-President:* Frank E. Adair, New York, N. Y.; *2nd Vice-President:* Eugene P. Pendergrass, Philadelphia, Pa.; *Secretary:* A. N. Arneson, 4952 Maryland Ave., St. Louis, Mo. (*Acting Secretary,* E. H. Skinner, 1532 Professional Bldg., Kansas City, Mo.); *Treasurer:* Leland R. Cowan, 606 Medical Arts Bldg., Salt Lake City, Utah.

*Executive Committee:* Lawrence A. Pomeroy, Chairman, Cleveland, Ohio, Frederick W. O'Brien, Boston, Mass., Hayes E. Martin, New York, N. Y.

*Program Committee:* Charles L. Martin, Chairman, Dallas, Texas, William S. MacComb, New York, N. Y., Eugene T. Leddy, Rochester, Minn., Herbert E. Schmitz, Chicago, Ill., John S. Bouslog, Denver, Colo.

*Publication Committee:* E. H. Skinner, Chairman, Kansas City, Mo., Zoe A. Johnston, Pittsburgh, Pa. Wilbur Bailey, Los Angeles, Calif.

*Research and Standardization Committee:* Edith H. Quimby, Chairman, New York, N. Y., J. L. Weatherwax, Philadelphia, Pa., W. S. MacComb, New York, N. Y.

*Education and Publicity Committee:* Ernst A. Pohle, Chairman, Madison, Wis., William H. Sargent, Oakland, Calif., Robert B. Taft, Charleston, S. C.

*Janeway Lecture Committee:* Douglas Quick, Chairman, New York, N. Y., E. H. Skinner, Kansas City, Mo., G. Failla, New York, N. Y., L. A. Pomeroy, Cleveland, Ohio, F. W. O'Brien, Boston, Mass., H. E. Martin, New York, N. Y.

*Representatives on American Board of Radiology:* Douglas Quick, New York, N. Y., B. P. Widmann, Philadelphia, Pa., F. W. O'Brien, Boston, Mass.

*Twenty-eighth Annual Meeting:* 1945, canceled.

# E D I T O R I A L

## THE ROENTGENOLOGIC EXAMINATION OF THE SMALL INTESTINE

IT IS quite singular that a comprehensive roentgenological study of so important a segment of the gastrointestinal tract as the small intestine, which plays such an important part in the body economy, should have been delayed so long. However, advancements in this field have only been made possible by a knowledge of the normal physiology and chemistry of the small intestine, and Golden is to be congratulated that he seized upon this knowledge at the earliest possible moment and put it to practical use in roentgen studies of the gastrointestinal tract, which offer a means of approach toward the unraveling of some of the clinical problems dealing with digestive disorders.

The book by Golden<sup>1</sup> which has recently been issued by Lippincott marks a milestone in the advance of roentgenology. In this he calls attention to a much neglected study in roentgen examinations of the gastrointestinal tract. When one realizes that it is only nine years since Barclay<sup>2</sup> published his epoch-making book on "The Digestive Tract" in which he covered in five pages in a volume of some four hundred pages our knowledge and methods of roentgen examination of the small intestine as known at that time, we may readily appreciate how much progress we have made in the study of this part of the digestive tract.

In his preface Golden points out that "the basic facts concerning the action and control of the small intestine are of importance to the surgeon and internist who

have to deal with the problems of abdominal diagnosis and the treatment of intestinal disorders." And furthermore, "Familiarity with these facts is even more important for the radiologist who tries to study this complex structure by roentgen methods."

The content of his book is sufficient evidence that Golden possesses a familiarity with these facts as a roentgenologist far greater than that of roentgenologists in general. He has produced a book that should become the constant companion of every roentgenologist who hopes to qualify as such, since the roentgen method of examination is valued in direct proportion to the roentgenologist's knowledge of the possible departures from the normal pattern in which the small intestine expresses itself and his ability to interpret these abnormal findings in clinical terms.

In every field of roentgenologic examination a sympathetic approach to the clinical problem involved must be constantly kept in mind and, as Golden says, in the field of roentgen examination of the small intestine this cooperative understanding is of the utmost importance; while the roentgenologist may demonstrate variations from the normal appearance of the small intestinal pattern the full significance of these pattern changes cannot always be thoroughly understood but "this should be a stimulating rather than a discouraging aspect of the problem."

That the roentgenologic study of the small intestine is in its early stages may be thoroughly accepted, but when one studies this book there is a realization that we have made enormous progress in this particular field within the last few years. A mere pe-

<sup>1</sup> Golden, Ross. *Radiologic Examination of the Small Intestine*. J. B. Lippincott Company, Philadelphia, 1945.

<sup>2</sup> Barclay, A. E. *The Digestive Tract: A Radiological Study of its Anatomy, Physiology, and Pathology*. Second edition. University Press, Cambridge, 1936.



rusal of the table of contents indicates the wealth of material which it contains. Beginning with "Indications for a small intestine study," together with "Technic" of the examination, it passes by easy stages over the "Embryology, anatomy, and physiology of the normal small intestine," continuing with "The normal small intestine on roentgen examination," "The small intestine of the infant," "Peritoneal adhesions and ileus," and a very splendidly written chapter on "The Miller-Abbott tube in the diagnosis and treatment of ileus." The chapter on "Disorders of nutrition" represents a high water mark in the study of gastrointestinal disorders in which recent developments in pathology and physiology are discussed, exposing not only known physiological facts concerning the small intestine but pointing to new fields of study dealing with its physiologic mechanism.

Golden, in his early studies on the small intestine, particularly those dealing with disorders of nutrition, coined the term "deficiency pattern." He says that this expression is inadequate and he suggests "Disordered motor function" as more descriptive and inclusive, as it carries with it no etiologic implications. The abnormal mucosal pattern is evidence of abnormal motor function of the muscularis mucosae just as the segmentation is due to disorderly action of the tunica muscularis. Disordered motor function of the small intestine is non-specific, and may be due to a number of different causes, and since this book will undoubtedly be the source of information dealing with the roentgen examination of the small intestine it would be well for the nomenclature used in these descriptive terms to become common knowledge.

There are other chapters of great importance, dealing with diseases of the mesentery, and the expression of the small

intestine pattern changes incident to allergy, and a thorough discussion of the well known inflammatory processes which involve the small intestine is included. There is an excellent chapter on the effects of certain drugs, namely morphine, strychnine, atropine, benzedrine, and the barbiturates, and a whole host of miscellaneous conditions are admirably grouped in some of the final chapters of this very stimulating study.

It is no exaggeration to say that no more important or thought-provoking book has been issued in the field of roentgenology than Golden's present volume. Here he has gathered together an enormous amount of material which represents his own keen observations on the studies of the gastrointestinal tract, and which also makes available in a very concise manner the work of other investigators. To have produced and published such a book even in normal times would deserve the gratitude of all roentgenologists but such an accomplishment under the stress of war conditions makes us doubly grateful. Such a book would not have been possible without a thorough knowledge of the recent advances in physiology, neurology and chemical changes during the digestive processes. The author is at great pains to emphasize that this book does not represent in any way the final chapter on this subject and he indicates in many places the gaps in our knowledge of normal motor functions as well as disordered motor functions of the small intestine. However, the volume with its systematic assemblage of known facts is a timely aid in our present needs in the study of small intestinal diseases and represents a foundation stone upon which future study and progress of roentgenologic examinations of the small intestine will be predicated.



# SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

*Items for this section solicited promptly after the events to which they refer.*

## MEETINGS OF ROENTGEN SOCIETIES\*

### UNITED STATES OF AMERICA

- AMERICAN ROENTGEN RAY SOCIETY**  
*Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: 1945, canceled.*
- AMERICAN COLLEGE OF RADIOLOGY**  
*Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago.*
- SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION**  
*Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: 1945, canceled.*
- ARKANSAS RADIOLOGICAL SOCIETY**  
*Secretary, Dr. J. S. Wilson, Mack Wilson Hospital, Monticello, Ark. Meets every three months and also at time and place of State Medical Association.*
- RADIOLOGICAL SOCIETY OF NORTH AMERICA**  
*Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: 1945, to be announced.*
- RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY**  
*Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.*
- SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION**  
*Secretary, Dr. Earl R. Miller, University of California Hospital, San Francisco, Calif.*
- RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY**  
*Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.*
- SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY**  
*Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.*
- RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL ASSOCIATION**  
*Secretary, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.*
- RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION**  
*Secretary, Dr. Roy G. Giles, Temple, Texas.*
- BROOKLYN ROENTGEN RAY SOCIETY**  
*Secretary, Dr. Leo Harrington, 880 Ocean Ave., Brooklyn, N.Y. Meets monthly on fourth Tuesday, October to April.*
- BUFFALO RADIOLOGICAL SOCIETY**  
*Secretary, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.*
- CHICAGO ROENTGEN SOCIETY**  
*Secretary, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.*
- CINCINNATI RADIOLOGICAL SOCIETY**  
*Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.*
- CLEVELAND RADIOLOGICAL SOCIETY**  
*Secretary, Dr. D. D. Brannan, 11311 Shaker Blvd., Cleveland 4, Ohio. Meets at 6:30 P.M. at Allerton Hotel on fourth Monday each month, October to April, inclusive.*
- DALLAS-FORT WORTH ROENTGEN STUDY CLUB**  
*Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meetings held in Dallas on odd months and in Fort Worth on even months, on third Monday, at 7:30 P.M.*
- DENVER RADIOLOGICAL CLUB**  
*Secretary, Dr. A. Page Jackson, Jr., 1612 Tremont Place, Denver, Colo. Meets third Friday of each month at Denver Athletic Club.*

- DETROIT ROENTGEN RAY AND RADIUM SOCIETY**  
*Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.*
- FLORIDA RADIOLOGICAL SOCIETY**  
*Acting Secretary, Dr. Walter A. Weed, 204 Exchange Bldg., Orlando, Fla. Meetings in May and November.*
- GEORGIA RADIOLOGICAL SOCIETY**  
*Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.*
- RADIOLOGICAL SOCIETY OF KANSAS CITY**  
*Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.*
- ILLINOIS RADIOLOGICAL SOCIETY**  
*Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.*
- INDIANA ROENTGEN SOCIETY**  
*Secretary, Dr. H. C. Ochsner, Methodist Hospital, Indianapolis. Meets annually second Sunday in May.*
- IOWA X-RAY CLUB**  
*Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.*
- KENTUCKY RADIOLOGICAL SOCIETY**  
*Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.*
- LONG ISLAND RADIOLOGICAL SOCIETY**  
*Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.*
- LOUISIANA RADIOLOGICAL SOCIETY**  
*Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.*
- MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS**  
*Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.*
- MILWAUKEE ROENTGEN RAY SOCIETY**  
*Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.*
- MINNESOTA RADIOLOGICAL SOCIETY**  
*Secretary, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.*
- NEBRASKA RADIOLOGICAL SOCIETY**  
*Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.*
- NEW ENGLAND ROENTGEN RAY SOCIETY**  
*Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.*
- NEW HAMPSHIRE ROENTGEN RAY SOCIETY**  
*Secretary, Dr. Richard C. Batt, Berlin, N. H. Four meetings a year.*
- RADIOLOGICAL SOCIETY OF NEW JERSEY**  
*Secretary, Dr. H. R. Brindle, 501 Grand Ave., Asbury Pk. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.*
- NEW YORK ROENTGEN SOCIETY**  
*Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.*
- NORTH CAROLINA ROENTGEN RAY SOCIETY**  
*Secretary, Dr. Major Fleming, Rocky Mount, N. C. An-*

\* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

nual meeting at time and place of State Medical Society.  
Mid-year scientific meeting at place designated.

#### NORTH DAKOTA RADIOLOGICAL SOCIETY

*Secretary*, Dr. L. A. Nash, St. John's Hospital, Fargo.  
Meetings held by announcement.

#### CENTRAL NEW YORK ROENTGEN RAY SOCIETY

*Secretary*, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse.  
Three meetings a year. January, May, November.

#### OHIO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.

#### PACIFIC ROENTGEN SOCIETY

*Secretary*, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

#### PENNSYLVANIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. L. E. Wurster, 416 Pine St., Williamsport.

#### PHILADELPHIA ROENTGEN RAY SOCIETY

*Secretary*, Dr. R. P. Barden, University Hospital, Meetings first Thursday of each month from October to May inclusive at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

#### PITTSBURGH ROENTGEN SOCIETY

*Secretary*, Dr. L. M. J. Freedman, 4800 Friendship Ave. Meets second Wednesday each month, 4:30 P.M., October to June, Pittsburgh Academy of Medicine.

#### ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

*Secretary*, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

#### ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

*Secretary* Dr. A.M. Popma, 220 N. First St., Boise, Idaho.

#### ST. LOUIS SOCIETY OF RADIOLOGISTS

*Secretary*, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September, at a place designated by the president.

#### SAN DIEGO ROENTGEN SOCIETY

*Secretary*, Dr. Henry L. Jaffe, Naval Hospital, Balboa Park, San Diego, Calif. Meets monthly on first Wednesday at dinner.

#### SAN FRANCISCO RADIOLOGICAL SOCIETY

*Secretary*, Dr. Carlton L. Ould, University of California Hospital, San Francisco 22. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

#### SHREVEPORT RADIOLOGICAL CLUB

*Secretary*, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

#### SOUTH CAROLINA X-RAY SOCIETY

*Secretary*, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

#### TENNESSEE RADIOLOGICAL SOCIETY

*Secretary*, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

#### TEXAS RADIOLOGICAL SOCIETY

*Secretary*, Dr. Asa E. Seeds, Baylor Hospital, Dallas, Texas. Next annual meeting, Temple, Texas, Jan. 17, 1945.

#### UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

#### UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE

*Secretary*, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00-5:00 P.M., Room 301, Service Memorial Institute.

#### VIRGINIA RADIOLOGICAL SOCIETY

*Secretary*, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

#### WASHINGTON STATE RADIOLOGICAL SOCIETY

*Secretary*, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

#### X-RAY STUDY CLUB OF SAN FRANCISCO

*Secretary*, Dr. J. M. Robinson, University of California Hospital. Meets monthly, third Thursday evening.

#### CUBA

#### SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA

*President*, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

#### BRITISH EMPIRE

#### BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY

Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

#### SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets on the third Friday of each month at 4:45 P.M. at the Royal Society of Medicine 1, Wimpole St., London, W. 1.

#### FACULTY OF RADIOLOGISTS

*Secretary*, Dr. M. H. Jupe, 32 Welbeck St., London, W. 1 England.

#### SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS

*Secretary*, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

#### RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION

*Secretary*, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

#### CANADIAN ASSOCIATION OF RADIOLOGISTS

*Secretary*, Dr. J. W. McKay, 1620 Cedar Ave., Montreal, P. Q.

#### SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

*Secretary*, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

#### RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION

*Secretary*, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

#### SOUTH AMERICA

#### SOCIEDAD ARGENTINA DE RADIOLOGIA

*Secretary*, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

#### SOCIEDAD PERUANA DE RADIOLOGIA

*Secretary*, Dr. Victor Giannoni, Apartado, 2306, Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión, Villalta, 218, Lima.

#### CONTINENTAL EUROPE

#### SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA

*Secretary*, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

#### SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)

*Secretary* for French language, Dr. A. Grosjean La Chaux de Fonds.

*Secretary* for German language, Dr. Scheurer, Molzgasse Biel. Meets annually in different cities.

#### SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

*Secretary*, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

#### ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

*Secretaries*, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

#### LENINGRAD ROENTGEN RAY SOCIETY

*Secretaries*, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

#### MOSCOW ROENTGEN RAY SOCIETY

*Secretaries*, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

#### SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

## DEPARTMENT OF TECHNIQUE

*Department Editor:* ROBERT B. TAFT, M.D., B.S., M.A., 103 Rutledge Ave.  
Charleston, S. C.

SPOT FILM FLUOROROENTGENOGRAPHY  
WITH MOVABLE GRID

By JACOB BUCKSTEIN, M.D.

*Assistant Professor of Clinical Medicine, Cornell University Medical College  
NEW YORK, NEW YORK*

THE value of fixing on the film the exact area of any part of the alimentary tract as observed roentgenoscopically is unquestioned. By this technique it becomes possible to roentgenograph an area when it

An apparatus, therefore, which permits of graded compression and almost instantaneous fixation on the film of an area observed under roentgenoscopic guidance has obvious merit and the procedure has achieved full recognition, although far from universal application.

A grid attached to the roentgenoscope is of great value in clarifying the image and bringing out maximum detail and should be a permanent part of any screen in roentgenoscopy of the alimentary tract. When the grid is fixed permanently to the fluorescent screen and the apparatus is used for immediate switch over for roentgeno-

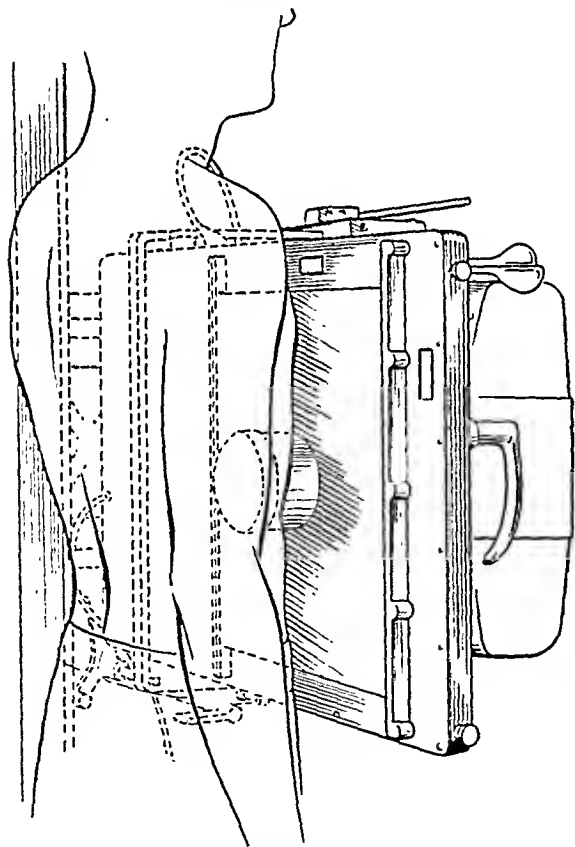


FIG. 1. Showing spot film device with cone in place against the abdomen.

shows to best advantage. By means of graded pressure it also becomes possible to produce that proper thinning of the opaque medium which will permit the visualization of lesions which might otherwise be obscured.

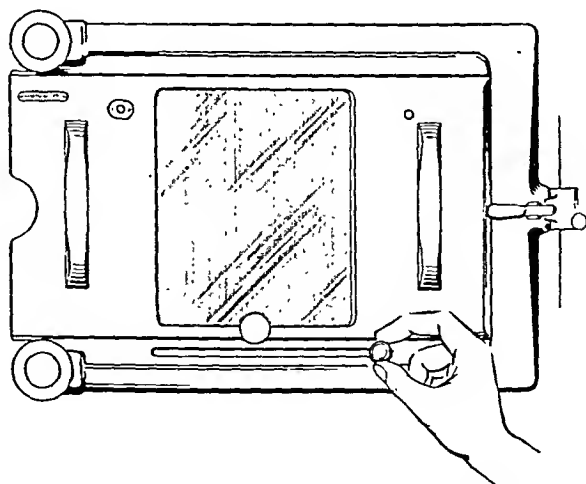


FIG. 2. Showing hand on the knob with the movable grid still in place.

graphic exposure, a good roentgenogram will be obtained which, however, is marred by the lines of the grid. It therefore occurred to me that if an arrangement could be made so that the grid would be in place

during roentgenoscopic study, and at the same time could be moved rapidly out of the way, simultaneously with roentgenographic exposure, it would then be possible to obtain a roentgenogram equal in quality to that obtained with the grid in place without the disadvantage of the grid lines.

Figure 1 shows the spot film device with cone in place against the abdomen. Figure 2 shows the grid in place in front of the fluorescent screen. This is the position of the grid during roentgenoscopy. When the area under observation is noted which it is desired to roentgenograph, the cone is moved into place so that it covers the exact area and graded compression is applied to bring out maximum detail. One may then by means of the switch-over mechanism promptly roentgenograph the desired area with the grid in place. As already stated, an excellent roentgenogram of the desired part may be obtained in this manner. The lines of the grid, however, will show and somewhat mar its appearance or even partially obscure some fine detail.

I therefore devised a simple method whereby the grid could be rapidly moved out of place after the roentgenoscopic examination had been completed and the area under observation fixed by the compression cone. The pressure of a button promptly releases a loaded cassette which shifts into position and simultaneously changes the setting from roentgenoscopic to roentgenographic exposure. The grid may be moved back and forth by an extremely simple mechanism through attachment to an external small metal knob which moves in a narrow horizontal slot. Figure 2 shows the hand attached to the knob with the grid still in place. Figure 3 shows the grid in transit as the hand moves the knob through the slot from right to left. Figure 4 shows the completed motion with the grid entirely out of the field of examination.

Roentgenographic examination with elimination of the grid lines may then be made in two ways. First, the movement of the grid can be started, preferably with the left hand, and roentgenographic exposure made

by contact of the switch with the right foot while the grid is in transit. With a little practice these two movements can be carried out almost simultaneously. In this

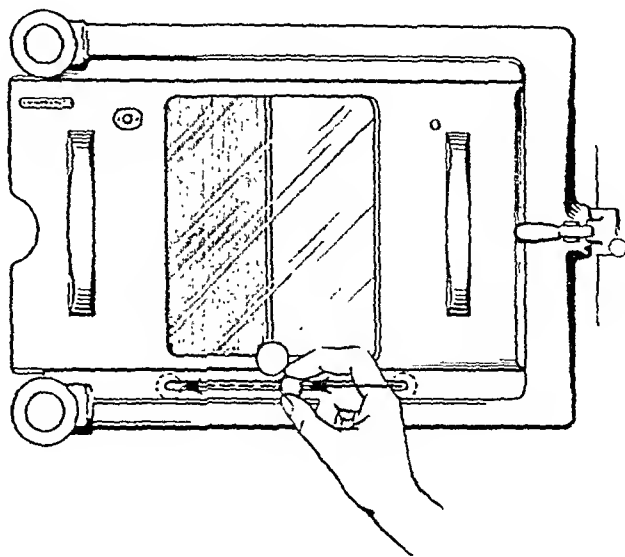


FIG. 3. Showing the grid in transit as the hand moves the knob through the slot from right to left.

manner secondary radiation is eliminated similar to the principle of the rapidly moving Potter-Bucky grid in general, and an excellent roentgenogram is obtained, at least the equal of the roentgenogram with the stationary grid. Another way in which a roentgenographic exposure may be made is first to rapidly move the grid completely

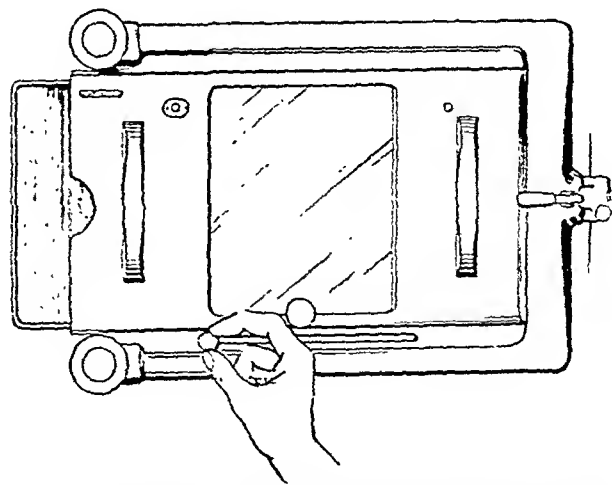


FIG. 4. Showing the completed motion with the grid entirely out of the field of examination.

out of the field and then step on the foot switch. Of these two procedures I prefer the former, since the roentgenogram so obtained is not only free of grid lines but shows better contrast.

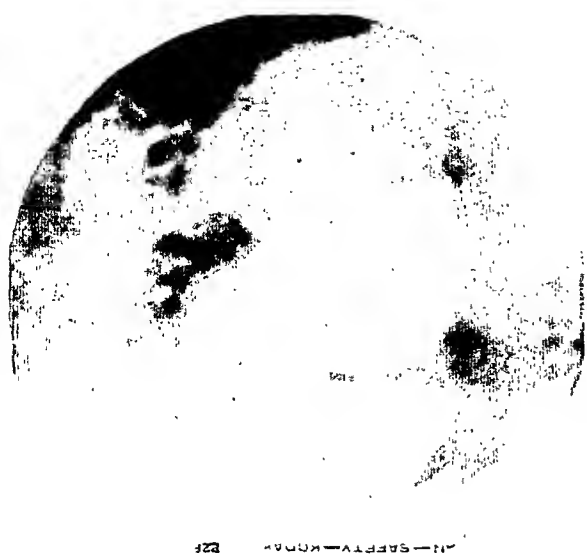


FIG. 5. Appearance of spot roentgenogram of duodenal bulb with the grid in place. Note presence of grid lines.

The movable grid thus adds greater flexibility to the spot film device, permitting roentgenographic exposures to be made under roentgenoscopic control (*a*) with the grid permanently in place, (*b*) during the actual movement of the grid across the field of exposure, and (*c*) after first completely moving the grid out of the field.

Figure 5 shows the appearance of a spot roentgenogram of the duodenum with the grid in place. The lines of the stationary grid are thereby included in the roentgenogram. Figure 6 shows a spot roentgenogram



FIG. 6. Spot roentgenogram of the same duodenal bulb as in Figure 5, exposure being made while the grid is in transit. Note absence of grid lines.

of the same area made simultaneously with the motion of the grid across the field of exposure. The grid lines do not show. On completion of the exposure the grid can then be shifted back to its original place in front of the screen for further roentgenoscopic observation.\*

1150 Fifth Ave.  
New York, N. Y.

\* I am indebted to the Westinghouse Electric and Manufacturing Co. for their cooperation in the construction of this innovation.



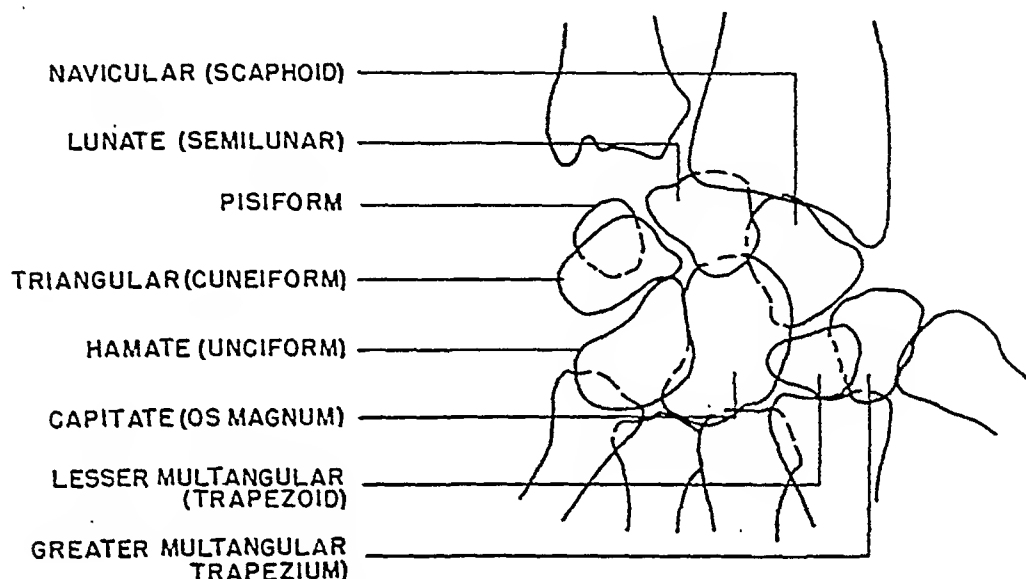
# THE ROENTGENOGRAPHIC EXAMINATION OF THE CARPUS

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ROENTGENOLOGISTS have evolved a series of positions which are designed to demonstrate thoroughly the anatomy under examination in many regions of the human body. After a study to determine the most widely preferred positions with which to examine the carpus, the conclusion

and without extension and flexion and with axial projections.

The resulting roentgenograms were presented to various roentgenologists for their study and opinions. It was concluded that at least five projections are required to make a complete examination of the car-



Drawing of the carpus in dorsivolar projection.

was reached that there is no generally accepted series of positions to supplement the standard posteroanterior and mediolateral projections.

In order to determine what minimum number of positions will demonstrate all of the carpal bones and joints, a normal wrist was examined using a total of fifty roentgenographic projections. The series was made with angulations of the central ray from the tube in proximal, distal, medial and lateral directions. The wrist was examined in various degrees of rotation, with and without deviation of the hand, with mediolateral and lateromedial positions with extension and flexion, and in posteroanterior and anteroposterior positions with

pus. These five projections were selected on the value of the series to show each carpal bone in one or more perspectives, the relationship of each carpal bone to the surrounding structures, and to outline the articular surfaces and interspaces.

Consideration for the patient with a severe and painful injury to the wrist region usually suggests the use of posteroanterior and lateromedial positions. The following positions are offered as a supplemental examination where the condition of the patient will permit using them and where a more complete examination is indicated.

1. *Posteroanterior View* (Fig. 1). The wrist is placed in pronation with ulnar

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FIG. 1. Posteroanterior view of the carpus.



FIG. 2. Oblique, posteroanterior view of the carpus.

deviation. The central ray from the tube is directed perpendicularly to the plane of the part and to the plane of the film. The centering point for the central ray is one-half inch distal to the mid-point of the interstyloid line.

If the mobility of the part permits ulnar deviation, a satisfactory view of the carpal bones and their interspaces is obtained. The



FIG. 3. Oblique, anteroposterior view of the carpus.

navicular and greater multangular bones are particularly well demonstrated. The lunate-triangular, capitate-hamate and the carpal-metacarpal interspaces are well defined.

With no ulnar deviation a slightly better view of the hamate is obtainable. However, there is an increase in superimposition which minimizes the visualization of the navicular and greater multangular bones. The interspaces are not clearly defined without an ulnar deviation.

2. *Oblique, Posteroanterior View* (Fig. 2). From the lateral position, with the medial side next to the film, the wrist is rotated

internally toward pronation until the volar surface is at a  $45^\circ$  angle to the plane of the film. The wrist is then deviated in the direction of the ulna. The central ray is directed perpendicularly to the center of the film through a point one-half inch distal to the center of the interstyloid line.

The proximal row of carpals is well defined. The greater and lesser multangulars and the proximal portion of the capitate is better visualized in this position than in routine positions. The following interspaces are well illustrated: navicular-greater multangular, greater multangular-first metacarpal and greater multangular-lesser multangular. Although some superimposition exists, this projection also demonstrates the articulation between the distal row of carpals and the first four metacarpals.

3. *Oblique, Anteroposterior View* (Fig. 3). From the lateral position with the ulna next to the film the wrist is rotated externally, toward supination, until the dorsal surface forms a  $45^\circ$  angle with the film plane. The wrist is deviated toward the ulna. The cen-



FIG. 4. Lateral, mediolateral view of the carpus.



FIG. 5. Axial view of the carpus.

tral ray from the roentgen tube is directed perpendicularly to the plane of the film, passing through a centering point one-half inch distal to the mid-point of the interstyloid line and then to the center of the film.

This roentgenographic projection demonstrates the proximal row of carpal bones with a minimum of superimposition and illustrates the relationship of the proximal row of carpal bones to those bones with which they articulate. The navicular, lunate, triangular and pisiform are particularly well defined.

The following articulating surfaces are well outlined: navicular-radius, lunate-radius, capitate-lunate, hamate-lunate, navicular-greater multangular and triangular-pisiform.

4. *Lateral, Mediolateral View* (Fig. 4). The forearm is placed in extreme internal rotation to bring the radial side next to the film and the dorsal surface at right angles to the plane of the film. The central ray is perpendicular to the film and is directed

through the styloid process of the ulna to the center of the film.

Although superimposition is present, the position permits a satisfactory lateral view of the following bones: navicular, lunate, triangular, greater multangular, capitate and hamate. The following interspaces are also demonstrated: first metacarpal-greater multangular, navicular-greater multangular, capitate-lunate, lunate-radius and navicular-radius.

5. *Axial View* (Fig. 5). The forearm is placed in pronation and in contact with the film. The wrist is extended and held in position by the patient. The degree of extension is dependent upon the mobility of the part, but a 90° extension is desirable. The central ray is directed at a 45° angle to the volar surface of the hand and passes through the mid-point of the interstyloid line to the center of the film.

This position offers a supplementary examination of the pisiform, the process of the hamate, the lesser multangular and the greater multangular bones.

I wish to express my gratitude to the following roentgenologists whose comments and opinions have

been especially valuable in the selection and preparation of this material: Charles W. Blackett, M.D., Bay State Road, Boston, Massachusetts, and Leonard Long, M.D., Caylor-Nickel Clinic, Bluffton, Indiana.

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# ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

## ROENTGEN DIAGNOSIS

### HEAD

COAKLEY, WALTER A., and WHITE, MALVIN F.  
Fractures of the zygoma. *Surg., Gynec. & Obst.*, Oct., 1943, 77, 360-366.

This paper represents a comprehensive study of 72 consecutive cases of fracture of the zygoma admitted to Kings County Hospital during the three year period from July, 1939, to June, 1942.

These fractures were always due to direct violence. The most important single cause was a vehicle accident. Sixty per cent of all the cases occurred in the age group ranging from twenty to thirty-eight years. The fractures had a preponderance in the male sex. The ratio of left sided injury to right was 3.5:1. There was an average of 3 fractures to each zygoma. The most frequent sites of fracture together with the incidence of their occurrence were as follows: arch, 119 times; infra-orbital, 44 times; frontal, 23 times; maxillary, 21 times.

*Signs and Symptoms.* (1) Periorbital swelling and ecchymosis; (2) local tenderness on palpation; (3) palpable depression or irregularity of contour; (4) pain—constant; (5) pain on mastication; (6) asymmetry between left and right sides on finger palpation intraorally between ramus of mandible and the maxilla; (7) epistaxis; (8) sensory changes over distribution of infra-orbital nerve; (9) conjunctival hemorrhage; (10) visual disturbances; (11) visible depression; (12) headache; (13) drooping of face and lip; (14) difficulty in opening mouth; (15) dizziness; (16) mobility or crepitus; (17) subcutaneous emphysema.

*Reduction of Fracture.* In general, fractures of the zygoma should be reduced immediately before swelling begins, or if that is impossible, it is better to wait five or six days until the swelling subsides. Two methods of operative approach have proved most useful in reducing these fractures: the temporal and the intraoral. —Mary Frances Vastine.

SAUNDERS, WM. W. Basilar impression: the position of the normal odontoid. *Radiology*, Dec., 1943, 41, 589-590.

The syndrome called basilar impression includes symptoms resembling those of syringomyelia, progressive spastic paralysis or multiple sclerosis in the region of the upper cervical cord and medulla, and shortening of the neck. Chamberlain holds that the diagnosis must be made by the roentgenologist on the basis of changes in the relations at the base of the skull, including displacement of the atlas and the tip of the odontoid process above their normal positions.

Lateral roentgenograms of the skulls of 100 normal persons were made to determine what the normal position of the odontoid process is. It was found to be 1 mm. below Chamberlain's line which runs from the dorsum of the hard palate to the dorsum of the foramen magnum. The standard deviation is 3.6 mm. In cases of any considerable deviation a careful examination of the foramen magnum should be made.—Audrey G. Morgan.

LAWSON, LAWRENCE T. Primary carcinoma of the eustachian tube; a study of the evidence of its occurrence. *Ann. Otol., Rhin., & Laryng.*, June, 1943, 52, 377-390.

Thirteen cases of primary carcinoma of the eustachian tube which have been reported in the literature are reviewed and the author adds a case report of his own. There is a discussion of the 14 cases from the following standpoints:

1. The symptoms of lateral wall nasopharyngeal tumor include:

- a. Pain due to irritation of the first and second branches of the fifth nerve.
- b. Post-nasal bleeding.
- c. Nasal obstruction.
- d. Obstruction of the eustachian tube with tinnitus and deafness and often—
- e. Painless unilateral cervical adenopathy.
- f. Symptoms referable to any of the cranial nerves other than the first and

second divisions of the fifth are an indication of extension of the tumor through the basal foramina, the jugular foramen or the orbital fissure.

2. Age and sex incidence. In this series of 14 cases, there were 13 men (ages 32 to 68) and 1 woman (age 54).
3. Pathology. In most instances, the neoplasm arises from the cartilaginous portion of the tube. According to Salinger and Pearlman, most of these tumors are thought to be transitional cell carcinomas or lympho-epitheliomas.
4. Clinical features. Symptoms referable to the ear were present in all cases. Intractable pain was present as the disease progressed.
5. Physical findings. There was early evidence of tumor involvement of the eustachian tube in 9 cases. Complete obstruction of the tube was present in 6 cases.
6. Treatment. The most favorable treatment would appear to be deep roentgen treatment combined with radium or radon.—*Mary Frances Vastine.*

#### NECK AND CHEST

COOPER, WILLIAM G., JR., and ACKERMAN, LAUREN V. Cystosarcoma phylloides, with consideration of its more malignant variant. *Surg., Gynec. & Obst.*, Sept., 1943, 77, 279-283.

Three cases of cystosarcoma phylloides of the female breast are reported.

**Definition.** Cystosarcoma phylloides is a tumor arising from the connective tissue of a pre-existing mammary adenofibroma.

**Clinical History.** The patient in her fourth or fifth decade has been aware of a quiescent, small, hard breast nodule for many years with later growth to a huge size without associated constitutional symptoms.

**Examination.** The breast is tremendously enlarged and characteristically ovoid in shape. The overlying skin and nipple are not invaded, although local extension may have taken place to the adjacent structures. Regional lymphadenopathy is not evident unless infection is superimposed.

**Pathology.** Grossly, the tumor is seen to contain frond-like pleats resembling a head of cauliflower. Microscopically, the characteristic finding is the increase in the fibrous elements.

**Prognosis.** Cystosarcoma of the breast is, like

all neoplasms, one whose potentialities vary from that of a very benign to that of a very malignant lesion.

**Treatment.** Treatment by wide local excision is usually satisfactory.—*Mary Frances Vastine.*

BERMAN, J. K. Nontuberculous empyema thoracis in children. *Surg., Gynec. & Obst.*, Feb., 1943, 76, 183-188.

A study of 184 cases of empyema before and since the use of the sulfonamides reveals the following observations:

1. The incidence of the disease varies from year to year and is apparently uninfluenced by their use.
2. There is a greater incidence of localized types of empyema.
3. Streptococcic and staphylococcic varieties are not as serious as formerly.
4. The stay in the hospital is prolonged.
5. The mortality is much less.
6. Complications are less frequent.

Roentgenoscopy is important to determine (1) whether or not localization has occurred and (2) the position of the encapsulated and interlobar varieties of empyemas. The method is based upon the fact that with localization comes fixation of the walls of the empyema cavity. In children, empyemas are usually massive so that fixation of the movable diaphragm and mediastinum are accurate guides. The mediastinum does not change as much in adults. However, even in localized cavities the phenomenon of fixation of the surrounding lung can be demonstrated.

In the child with empyema a thoracentesis is done to determine the type of organism, to partially empty the cavity of pus, and also to inject air. Roentgenoscopy is now done. It includes three maneuvers:

1. The child is first observed in the upright position. The fluid level is easily seen and before localization moves with respiration. It descends with the diaphragm on inspiration and ascends on expiration. After localization two phenomena have been observed: (a) no movement—this is seen in bilateral and sometimes unilateral empyema; (b) paradoxical movement—this is seen in unilateral empyema due to an exaggerated movement of the opposite leaf of the diaphragm.
2. The child is next observed in the Trendelenburg position (head down). In this

position the diaphragm can be seen easily if a sufficient amount of air is present in the empyema cavity (20 to 30 cc. of pus or more must be aspirated and an equal amount of air injected for visualization of the diaphragm). Fixation of the diaphragm implies localization.

3. The third maneuver includes examination of the child anteroposteriorly in the lateral decubitus plane. The pus gravitates away from the mediastinum permitting observation of its movements when the patient is turned on the affected side. If the mediastinum is fixed the cavity is completely localized and open drainage may be safely done.—*Mary Frances Vastine.*

CLAGETT, O. THERON. Relationship between the thymus and myasthenia gravis. Editorial. *Surg., Gynec. & Obst.*, Feb., 1943, 76, 250-252.

Evidence of an association between myasthenia gravis and abnormalities of the thymus has been accumulating since 1901 when Weigert reported finding a tumor of the thymus in post-mortem examination of a patient who had died with myasthenia gravis. At the Mayo Clinic in the past year 7 patients having myasthenia gravis were found to have roentgenographic evidence of intrathoracic tumors. In 3 instances surgical removal and histological study verified the clinical opinion that the tumors were of thymic origin.

The exact nature of the relationship is not known but the association occurs too frequently to be considered coincidental. There is some evidence to suggest that myasthenia gravis may be an endocrine type of disease due to an abnormal secretion from the thymus having a curare-like effect. Further evidence that the thymus may be a part of the endocrine system is contributed by the fact that in thyrotoxicosis and in Addison's disease the thymus is enlarged and that it undergoes an involution following thyroidectomy in cases of thyrotoxicosis or injection of cortical extract in Addison's disease. Likewise the gonads and the pituitary gland have been shown by some to have some definite influence on the thymus.

Although the rôle of roentgen irradiation of the thymus in the treatment of myasthenia gravis is not established, a number of observers have noted that roentgen therapy over the thymic region in cases of myasthenia gravis

has produced improvement or remission of symptoms, and in some cases definite roentgenologic evidence of thymic enlargement disappeared following roentgen therapy. The author's own experience has confirmed the beneficial effects of roentgen therapy for the relief of symptoms of myasthenia gravis in selected cases.—*Mary Frances Vastine.*

GRATIOT, JOHN H. Carotid-body tumors; collective review. *Internat. Abstr. Surg.*, 1943, 77, 177-186. In *Surg., Gynec. & Obst.*, Sept., 1943.

During the sixty-two years since the first carotid-body tumor was described, not more than 250 cases have been reported. The subject is reviewed and 2 new cases are added.

*Gross Anatomy.* The human carotid body measures 5 by 3 by 2 mm. It is connected to the carotid bifurcation by a fibrovascular band, the ligament of Mayer. After the age of twenty or thirty years the fibrous stroma increases at the expense of the parenchyma. The arterial supply is from the carotid bifurcation. Nerves are received from the glossopharyngeal and the superior cervical sympathetic ganglion, from the vagus and the hypoglossal.

*Embryology*—unknown. Boyd believes that this is a dual organ from the mesoderm of the third branchial artery and the ectoderm of the glossopharyngeal nerve.

*Function*—unknown. These glands are not essential to life or good health. They are not endocrine organs.

*Pathology.* Carotid-body pathology is confined to that of tumors. Probably from 15 to 20 per cent of carotid-body tumors become malignant. They remain benign for years and then are only locally malignant. Distant metastases are rare. Perhaps they never occur.

*Etiology*—unknown. Most of the patients are between the ages of twenty-five and sixty years. Both sexes are equally susceptible.

*Symptoms.* Often the only symptom is the presence of a swelling below and behind the angle of the jaw. Other symptoms are due to pressure on surrounding structures. In a very small number of cases, perhaps 3 per cent, various manifestations of the carotid sinus syndrome occur. (The symptoms attributable to the carotid-sinus syndrome are dizziness, weakness, faintness (usually in the upright position), spots before the eyes, epigastric distress, and unconsciousness.) A tumor is not necessary to



cause this reflex . . . which is produced through the sinus nerve. The reflex proceeds through one of three routes: (1) Vagal route. The symptoms are due to vagus stimulation with cardiac asystole, sino-auricular or auriculoventricular block, and fall in the blood pressure which result in dizziness and faintness. The symptoms are prevented by adrenalin and relieved by atropine. (2) Depressor nerve route. The symptoms are due to vasodilatation with fall in blood pressure and cerebral anoxia. They are relieved by adrenalin. (3) Cerebral type. The impulse goes directly to the medulla and hypothalamus. Atropine and epinephrine are of no benefit.

*Differential Diagnosis.* (1) Aneurysm of carotid artery; (2) metastatic malignancy; (3) malignant lymphomas; (4) inflammatory lymph nodes; (5) aberrant thyroid tissue; (6) brachial-cleft cysts; (7) branchiogenic carcinoma; (8) thyroglossal duct cysts.—*Mary Frances Vastine.*

CLERF, LOUIS H., COOLEY, E. E., and O'KEEFE, J. J. Esophagobronchial fistula. *Surg., Gynec. & Obst.*, Dec., 1943, 77, 615-617.

Fistulas between the food passages and the tracheobronchial tree have been classified into four main groups:

1. Congenital.
2. Neoplastic.
3. Infectious. The infectious cases may be of syphilitic, tuberculous, or nonspecific origin. The tuberculous type occurs most often in children and is apparently the result of the breaking down of a tuberculous lymph node.
4. Traumatic. These cases are commonly caused by swallowed irregular or pointed foreign bodies, such as bones. The trachea or left main bronchus should be more commonly involved because of their close proximity to the esophagus.

Two patients with esophagobronchial fistula between the right main bronchus and esophagus which existed for nine and thirty-two months, respectively, are reported. No definite cause could be demonstrated although one patient had developed a pulmonary abscess and coughed up a mass of necrotic tissue immediately preceding the development of symptoms. There was no apparent tendency for the fistula to close after the esophagus was placed at rest. Prompt closure of the esophageal end of the fistula resulted following the esophagoscopy

application of sodium hydroxide crystal fused on a curved metal applicator and carried into the fistula for a distance of several centimeters. Both patients have been free from symptoms for over eighteen months.—*Mary Frances Vastine.*

HAGENS, E. W. Anatomy of the tracheobronchial tree from the bronchoscopic standpoint. *Arch. Otolaryng.*, Nov., 1943, 38, 469-475.

The author dissected 20 pairs of lungs from cadavers and took measurements which are tabulated in the article. Some general observations were made:

#### *Right Lung*

1. While the right lung usually has three lobes, these may be incompletely separated. In five specimens only two lobes occurred. In one specimen four lobes were found, the fourth being a medial or azygos lobe.
2. The right upper lobe bronchus usually divides into three branches. In four specimens there were only two, and in one lung there were four branches.
3. The right middle lobe bronchus is always present even though there is no middle lobe. In the latter case it supplies the lower part of the upper lobe.
4. The right lower lobe bronchus usually branches into (a) a dorsal branch coming off immediately, (b) a medial branch coming off within a centimeter and (c) irregularly placed branches from the main continuation downward.

#### *Left Lung*

1. The left lung usually consists of two lobes.
2. The left upper lobe bronchus divides into two branches.
3. The left lower lobe bronchus generally divides into a number of branches. A dorsal branch comes off within a centimeter of the orifice. It supplies the upper part of the left lower lobe. The main continuation after about 2 cm. divides into two rather equal branches. These are separated by an approximately horizontal spur, and they continue downward, one above the other to supply the basal part of the left lower lobe.

#### *The Blood Vessels about the Hilar Region.*

1. The aorta crosses anterior to the trachea, just above the bifurcation of the latter,

and after turning down, passes underneath the left main bronchus.

2. The left pulmonary artery, as well as the upper left pulmonary vein just below, cross anteriorly over the left main bronchus. The lower left pulmonary vein courses anteromedially to the left lower lobe bronchus.
  3. The right pulmonary artery passes anteriorly across the right main bronchus just below the orifice of the right upper lobe bronchus. As on the left side, the upper pulmonary vein is closely associated with the artery. Adjacent to the right lower lobe bronchus and especially its medial branch is the right lower pulmonary vein.
- Mary Frances Vastine.*

CLEAVER, E. E. Chronic peptic ulceration of oesophagus. *Am. J. Digest. Dis.*, Sept., 1943, 10, 319-329.

In this series of 10 cases, there were 5 males and 5 females, they were between the age of thirty and seventy-nine years. Pain was a definite symptom in 7 cases. This generally commenced in the lower sternal region, sometimes coming on half to one hour after meals and was relieved by taking food or an alkali. The pain was often described as a burning sensation behind the sternum and was often worse when the patient was lying down. It was sometimes associated with regurgitation of acid mouthfuls. Again the pain might radiate to the back, to both shoulders and sometimes down one or both arms. Pain of a burning character was occasionally felt when patient bent forward. It was not infrequently of the peptic ulcer type, might be present daily for several weeks or months. Pain at first occurs when hard solids are taken; very hot or cold drinks, acids, condiments, etc., frequently produce it. The duration of pain may vary from a few minutes to hours unless relieved by alkalis or antispasmodics.

Dysphagia may be present from the onset of the disease but generally develops after the pain has been present for some months. This symptom is not present until obstruction develops. The obstruction may be due to either spasm or actual stenosis or both. Great distress may be experienced if stenosis is complete and patient is unable to belch gas from the stomach into the esophagus. One of the patients had suffered with choking spells for fifteen years; attacks of dysphagia had been frequent for the

past ten years; however, pain had been present for only the past few months.

Hemorrhage is generally not an early symptom but occurs following a long history of pain and dysphagia. Occasionally bright red blood or coffee-colored material is regurgitated; in a later stage, a profuse hemorrhage may occur and may prove fatal. Severe anemia frequently results from a large or repeated small hemorrhages. In this series definite hematemesis occurred in 3 cases, whereas 7 had no hemorrhage.

The roentgenological findings were positive for short esophagus and diaphragmatic hernia in 7 cases. Esophagoscopy was done in 8 cases. In 2 cases biopsy showed ectopic gastric mucosa. One case had both ectopic gastric mucosa and short esophagus associated with a diaphragmatic hernia; the other case showed ectopic gastric mucosa but no short esophagus.—*Franz J. Lust.*

STEIN, GEORGE H. Pneumonic densities obscured by the cardiac shadow. *Radiology*, Dec., 1943, 41, 576-579.

Roentgenograms of a series of proved pneumonia cases have shown that areas of pneumonic density may be hidden by the heart shadow. The fact that one area of density may be visible does not prove that there are no others, hidden in the heart shadow. Left oblique or left lateral projections may serve to reveal such hidden densities.

Four cases are described and illustrated with roentgenograms showing the location of the obscured densities. In one case there was a pneumonia in the left lower lung field with the mesial part of the spherical consolidation extending behind the heart shadow. This gave a curious half-moon image of the remaining part of the consolidation on the roentgenogram.—*Audrey G. Morgan.*

PAUL, LESTER W. Roentgenologic aspects of acute and chronic esophagitis. *Radiology*, Nov., 1943, 41, 421-430.

Esophagitis is a common complication of other diseases of the esophagus, such as carcinoma, diverticula, cardiospasm and ulcer. The acute ulcerative form is most commonly seen in association with peptic ulcer, particularly of the duodenum, or after operation for the relief of such ulcers. Chronic esophagitis may be a chronic infection or the fibrous residue of previous infection. Both are uncommon clin-

ically. It is probable that a decided lowering of resistance must occur before acute ulcerative esophagitis can develop. It may be brought about by anything that causes relaxation of the cardia, permitting acid gastric juice to come into contact with the esophageal mucosa. The chief clinical symptoms are substernal pain, dysphagia and hematemesis. The roentgen signs of the acute form are diffuse spasm of the lower esophagus, loss of normal mucosal folds, a fine roughening of the margins and considerable obstruction. In the chronic form the chief roentgen signs are those of diffuse fibrous stricture or in some cases intermittent diffuse spasm of the lower half or third with thickening of the mucosal folds.

Five cases are described and illustrated with roentgenograms.

In the discussion Dr. Templeton said that esophagitis may involve only the mucosa and not the submucosa. In that case the diagnosis cannot be made by roentgen examination. He prefers to use only the anatomical signs for diagnosis, such as thickening of the mucosal folds, shallow ulceration and fissure. He is not sure that the spastic phenomena are diagnostic of esophagitis. It is possible that carcinoma and peptic ulcers of the esophagus are complications of esophagitis rather than esophagitis being a complication of peptic ulcer and carcinoma.—*Audrey G. Morgan.*

BIHSS, FRANCIS E., and BERLAND, HARRY I. Roentgenological manifestations of pleuropulmonary involvement in tularemia. *Radiology*, Nov., 1943, 44, 431-437.

The authors discuss 81 cases of tularemia seen by them in 36 of which there were chest symptoms. In 29 of these roentgenograms of the chest were made. The cases are divided into two groups: 72 of the ulceroglandular, glandular and oculoglandular types and 9 of the typhoid type. Of the 72 cases in the first group, 27 had symptoms or physical signs referable to the chest. In 19 there was roentgen evidence of pleuropulmonary involvement beginning with hilar adenopathy followed by retrograde extension through the lymphatics into the lung parenchyma or even into the pleura, resulting in effusion. In this group of 19 cases there were 4 deaths, while in the 53 cases that did not show pulmonary lesions there was only 1 death from septicemia. In the second group of 9 cases of typhoid tularemia all had signs of lung in-

volvement. These showed involvement of the parenchyma resembling that of pneumonia and the hilar nodes were generally not enlarged. Seven of these patients had pneumonia, in 1 case complicated by abscess formation. Three of these 7 patients died.

Nine cases illustrative of these two types of lung involvement in tularemia are described and illustrated with roentgenograms.—*Audrey G. Morgan.*

#### ABDOMEN

VINSON, PORTER P. Treatment of dysphagia from hernia through esophageal hiatus in diaphragm. *Arch. Otolaryng*, July, 1943, 38, 27-31.

There are two types of diaphragmatic hernia in which dysphagia is often the predominating symptom. One of these is the para-esophageal hernia and the other is the short esophageal hernia.

The author has seen 53 diaphragmatic hernias over the past six years. Of these, 11 were para-esophageal, 3 in men and 8 in women. Forty-two had short esophageal hernias and of these, 18 were in men and 24 in women. All the patients were more than forty years of age. The difficulty in swallowing was more pronounced in those with the short esophageal type. In this type dysphagia results from spasm or stricture at the junction of the esophagus and the hernial sac. In persons with hernia of the para-esophageal type it results from stricture in the lower portion of the esophagus, spasm at the cardia or pressure from the herniated portion of the stomach on the lower part of the esophagus. It is hard to explain why, in the patients who have congenital shortening of the esophagus, there is seldom dysphagia before forty years of age although the deformity has presumably been present since birth.

The signs and symptoms of diaphragmatic hernias (the para-esophageal and short esophagus hernias) which may be noted include:

1. Intermittent dysphagia observed on swallowing any type of food, solid or liquid.
2. Constant fear of choking.
3. Complete esophageal obstruction from a bolus of meat (for example) may occur.
4. Bleeding may take place as the result of ulceration at the junction of the esophagus and the hernial sac.
5. Cicatricial stricture may occur as the result of recurring ulceration and healing.

(When cicatricial stricture is present in diaphragmatic hernia, the resultant dysphagia is indistinguishable from benign stricture from other causes.)

6. Gaseous distention especially after meals and when the patient is lying down at night. The degree of distress usually depends on the size of the hernial sac and is therefore more pronounced in patients with para-esophageal hernia.
7. Epigastric and substernal pain which may be indistinguishable from that of coronary disease, cardiospasm or gallbladder colic pain.
8. Severe anemia may occur. The bleeding may be prolonged oozing or it may be a sudden severe hemorrhage.

As for treatment, operation is the most satisfactory procedure in the para-esophageal type of hernia. For patients with congenital shortening of the esophagus with hernia, operation is not satisfactory. Passage of dilating sounds over a previously swallowed silk thread will provide satisfactory results.—*Mary Frances Vastine.*

JENKINSON, E. L., and LATTEIER, K. K. Non-organic gastric filling defects simulating carcinoma. *Radiology*, Nov., 1943, 41, 444-450.

Two cases are described and illustrated in which roentgen examination showed filling defects seemingly those of carcinoma. On the basis of the findings operation was performed and no abnormality found. Even sections removed for microscopic examination showed nothing abnormal. It was decided that the findings had been caused by spasm which had not been relieved by the administration of atropine. It is quite true that changes similar to those of carcinoma may be caused by spasm. Deformities involving only the walls of the stomach may be due to spasm. It has been believed that spasm of the pyloric antrum looks smooth and narrow on roentgen examination but this was not so in these cases. If an absolutely reliable antispasmodic could be found it would greatly aid diagnosis in such cases. The qualities of various antispasmodics are discussed.

While the authors accept the pathologist's report they still think this spasm may be an early manifestation of some lesion that may later prove more serious. In the discussion several of the discussants agreed with this view.—*Audrey G. Morgan.*

STEIGMANN, FREDERICK. Considerations on the diagnosis of large gastric ulcers and implications as to treatment. *Am. J. Digest. Dis.*, March, 1943, 10, 88-93.

It is evident that large gastric ulcers are significantly more often malignant than are smaller lesions. The hazards confronting the clinician, roentgenologist, and gastroscopist in the differential diagnosis of large gastric ulcers are great and this fact needs to be re-emphasized. The results of this study of large gastric ulcers, extending over a period of ten years, support similar previous reports showing that there is nothing in the history, physical examination, laboratory tests, findings on roentgen study, gastroscopy, or in the results of medical treatment which will unfailingly differentiate a benign from a malignant gastric ulcer. In some cases only the histopathologic examination of the excised lesion will lead to correct diagnosis.

The therapeutic implications of the foregoing considerations would seem to be clear. To the author, as to many others, the observations here reported suggest the advisability of resecting every large gastric ulcer. As pointed out in a previous paper, resection of large gastric ulcers is advisable not only because of the danger of misdiagnosing a malignant lesion as benign, but also because the complications of these large gastric ulcers make them in a way malignant when they are histopathologically benign. Surgery is advised by the author for large gastric ulcers even though he is aware of Bloomfield's conclusion that errors in differential diagnosis do not exceed the mortality rate of resection. This conclusion seems inapplicable to the clinic where he works where the mortality from operations is not high.

For years the author followed the plan of closely observing his patients with large gastric ulcers until the lesion was completely healed. The results, however, were not entirely satisfactory inasmuch as even when the lesion was not malignant, he frequently saw recurrences and complications after apparent complete healing and finally he often had to operate. From such observations, he would hesitate to say that there is such a thing as complete healing of a large gastric ulcer on medical treatment. The excellent paper by Palmer and his associates supports this view. Considering, therefore, the complications that may arise from large gastric ulcers, even when they are benign, and the possibility that they may be carcino-

matous, it seems to him that one can never rest content until such a lesion is resected.—*Franz J. Lust.*

PEARL, FELIX L., and BRUNN, HAROLD. Multiple gastric polyposis. *Surg., Gynec. & Obst.*, March, 1943, 76, 257-281.

This report is an analysis of 41 cases of gastric polyposis having 3 or more polyps. It is supplementary to a previous report of 84 cases published by Brunn and Pearl in 1926. The report is high-lighted in the summary:

1. Multiple gastric polyposis may be congenital (or neoplastic) or inflammatory (or hyperplastic). The condition of multiple gastric polyposis stops abruptly at the duodenum.
2. The symptoms are not characteristic. In the series, epigastric pain and tenderness were most frequent. In over half of the cases bleeding was found to take place in the vomitus, stool, or gastric content. Pedunculated tumors and those near the pylorus are more apt to give symptoms of separation of polyps or pyloric obstruction. Some patients have had symptoms over twenty years.
3. The roentgenogram may fail to differentiate multiple polyposis from chronic hypertrophic gastritis, retained food, bezoar or sarcoma. The correct diagnosis was made most often by roentgen examination and by operation, but the condition was often overlooked by the roentgenologist. In the 41 cases, the correct diagnosis was made by roentgen examination in 17, by operation in 13, by examination of the excised surgical specimen in 5, and by autopsy in 6.
4. Gastroscopy is a valuable aid in the diagnosis of gastropathies especially in the differentiation between benign and malignant lesions and between polyposis and hypertrophic gastritis.
5. Free hydrochloric acid was absent from the gastric contents in almost every case.
6. Of the 41 cases, 4 gave no malignancy data. Of the remaining 37, malignant alteration was found in 19. This argues for radical surgical removal of the tumor-bearing area by gastric resection as soon as the diagnosis is made.—*Mary Frances Vastine.*

MELAMED, A., and HILLER, ROBERT I. Prolapsed gastric mucosa; roentgenologic demonstration of ulcer crater in prolapsed polypoid mucosa. *Am. J. Digest. Dis.*, March, 1943, 10, 93-95.

A case of prolapsed polypoid gastric mucosa, visualized by roentgen examination and verified by surgery, is presented. Severe melena arising from two ulcers on the prolapsing mucosa was the outstanding symptom. At least one of the ulcers was demonstrable on the roentgenograms.—*Franz J. Lust.*

SMITH, LUCIAN A., and RIVER, ANDREW B. Gastroileostomy and gastroileal ulcer. *Surg., Gynec. & Obst.*, Jan, 1943, 76, 110-114.

A complication which may follow gastroenterostomy is a stoma which is gastroileal instead of gastrojejunal. This low anastomosis is the result of a surgical error. At the Mayo Clinic approximately one diagnosis of this condition is made in each one to two years. Roentgenological examination is of the greatest value in making the diagnosis.

In this paper, 9 cases of gastroileostomy are reported. The symptoms of gastroileostomy are discussed. They include:

1. Diarrhea which characteristically begins soon after operation and often is lenteric in type.
2. Vomiting which occasionally has a fecal quality.
3. Loss of weight which varies with the severity of the diarrhea.
4. Pain of the bowel type when unmixed with that of gastroileitis or gastroileal ulcer. This type of pain is lower abdominal and cramping with relief on passage of flatus, stool, or an enema. Gastroileitis and gastroileal ulcers may simulate gastrojejunal ulcer clinically. They are present only when the concentration of free acid is significant. Gastroileitis was present in 1 case and gastroileal ulcer in 3 cases of the series reported.—*Mary Frances Vastine.*

BROWN, SAMUEL, MCCARTHY, J. E., and FINE, ARCHIE. The roentgen diagnosis of biliary tract tumors. *Radiology*, Nov., 1943, 41, 459-463.

The word tumor as used here applies to all enlargements, inflammatory, non-inflammatory or neoplastic. In roentgen examination a fluoro-

scopic inspection should first be made of the chest, and then a general survey of the abdomen with plain roentgenograms and, third, a study of the gastrointestinal tract for possible changes produced by pressure.

One of the most frequent findings is elevation of the diaphragm on the right side due to enlarged liver, subphrenic abscess, phrenic paralysis, atelectasis or eventration. If the cause of the elevation is not known the diagnosis can generally be established by examination of the stomach and intestines with a barium meal and enema. In enlargement of the liver the stomach and duodenum are displaced to the left and backward and the colon downwards. In all of the other conditions the stomach and colon are usually pulled upward in the same direction as the liver.

In taking the plain views of the abdomen, in addition to anteroposterior and lateral views, a left anterior oblique view should be used to separate the shadow of the right kidney from a superimposed shadow of an enlarged gallbladder.

In the roentgen diagnosis of tumors of the common duct it is necessary to have an accurate knowledge of the exact relationship between the gallbladder, ducts, pancreas and duodenum. There may be defects in the lumen of the duodenum at or just beyond the superior angle due to pressure from dilatation of the neck of the gallbladder, the cystic or common duct, caused by obstruction by a stone or tumor. The most satisfactory view for demonstrating a pressure defect in the duodenum is the right lateral or right anterior oblique with the patient lying on the horizontal fluoroscope.

Roentgenograms are given showing the different forms of tumors of the liver, gallbladder and extrabiliary tract.—*Audrey G. Morgan.*

BRUNSCHWIG, ALEXANDER, and TEMPLETON, FREDERIC E. Roentgenographic diagnosis of neoplasms of the peri-ampullary region and head of the pancreas. *Radiology*, Nov., 1943, 41, 438-443.

As carcinomas of the head of the pancreas and of the ampulla of Vater can be totally excised, together with the duodenum, it is very important to be able to make an early roentgen diagnosis of such tumors. Peri-ampullar tumors can be seen more readily than those of the head of the pancreas as the latter sometimes do not make changes in the outline of the duodenal curvature.

Ampullar carcinomas may be polypoid and protrude into the lumen of the duodenum, in which case they are readily recognizable. A tumor inside the ampulla expands it and gives the picture of a smooth, enlarged papilla of Vater. These are sometimes not detected because of inability to produce marked distention of the duodenum by barium. Ampullar carcinomas may also show flattened ulcerations with raised rolled edges. Extensive infiltration of the wall of the duodenum by carcinoma of the ampulla or carcinoma primary in the second portion of the duodenum causes great distortion of the wall and rigidity of the involved segment, and should be easily detected. In these cases the normal mucosal markings are replaced by irregular coarse markings and polypoid masses may protrude into the lumen. Even in such advanced cases operation may be possible. Frostberg's reversed 3 (e) sign indicates edema of the papilla resulting from tumor in or near the ampulla. It is of great value when positive but of little or none when negative. But all of the signs of carcinoma of the ampulla may be present and there may be no tumor.

As mentioned before, small carcinomas of the head of the pancreas may show no signs of distortion of the duodenum but such small tumors in the periphery of the head may invade the duodenum and cause areas of rigidity or even ulcerations. These different types of carcinoma are illustrated with roentgenograms.

But even if there is no roentgen evidence of tumor, exploratory operation should be performed if there is the clinical picture of obstructive icterus, unassociated with typical gallstone colic and possibly accompanied by an enlarged, distended and palpable gallbladder. Nor should laparotomy be refused because there is roentgen evidence of extensive involvement of the duodenum, as the resection of even large tumors in this region will give some palliation to the patient whose average length of life without treatment is but six or eight months.—*Audrey G. Morgan.*

GILE, JOHN F., and MACCARTY, WM. C., JR. Calcified concretions within a Meckel's diverticulum. *Radiology*, Nov., 1943, 41, 491-494.

Calcification in appendiceal concretions dense enough to cause a shadow on the roentgenogram have been described before but so far as the authors know no case has been described in the American literature in which calcified con-



cretions in a Meckel's diverticulum were demonstrated surgically. Such a case is described in a white man, aged thirty-four, who complained of nausea, vomiting and abdominal pain. The clinical impression was that of acute intestinal obstruction. A roentgenogram showed multiple distended loops of small bowel with an abnormal amount of gas in the colon. There were two irregular areas of calcification in the right lower abdomen which were thought to be calcified lymph nodes. Exploratory laparotomy was performed and showed a Meckel's diverticulum arising about 20 inches above the ileocecal valve which ran down freely without a mesentery to the right pelvic wall. At this point the distal end was attached to the tip of the appendix. The diverticulum and the appendix formed a band behind which a loop of ileum had become lodged and obstructed. It is believed that appendicitis with adhesions and rupture into the diverticulum laid the foundation for the resultant intestinal obstruction.

Drawings of the specimen are given.—*Audrey G. Morgan.*

Mulsow, F. W. Meckel's diverticulum containing calculi. *Am. J. Digest. Dis.*, May, 1943, 10, 188-189.

Reports of calculi in Meckel's diverticulum are very rare. Only 9 previous reports could be found, yet it has been estimated by various authors that 1 to 2 per cent of the population have a Meckel's diverticulum. There are many reports in the literature of cases, yet only 2 cases of calculi in it could be found in the American literature. Such calculi when seen in roentgen examinations might be mistaken for calcified lymph nodes, renal calculi or phleboliths. These stones have the appearance of gallstones in a few instances. It appears, however, that by proper physical and chemical examinations they can be distinguished from gallstones. In the present case the stones were obviously formed in the diverticulum. The association of an acute appendix with the acute diverticulitis or other acute abdominal conditions is not unexpected, and in the reported instance reveals the value of a thorough exploration where possible in acute abdominal conditions. *Franz J. Lust.*

Kennedy, Roger L. J., Dixon, Claude F., and Weber, Harry M. Polypoid lesions of the colon of children. *Surg., Gynec. & Obst.*, Dec., 1943, 77, 639-644.

This paper is based on the study of 11 cases of polypoid lesions of the colon. In all of these cases the patients were children and the colonic lesions were situated beyond the reach of the sigmoidoscope.

#### Symptoms.

1. Blood in the stools was the outstanding symptom.
2. Small amounts of clear or blood-tinged mucus were observed in 5 cases.
3. Pain was not a prominent symptom.
4. Diarrhea was present in only 1 case.
5. Polypoid lesions of the colon were frequently associated with similar lesions of the rectum.

#### Diagnosis.

1. The blood is bright red indicating that the source of the bleeding is in the lower part of the gastrointestinal tract, certainly below the ileocecal valve.
2. The blood is usually on the outside of the stool and is not mixed with it as is usually the case in which the bleeding is due to lesions of the small intestine, such as Meckel's diverticulum.
3. The bleeding is not associated with diarrhea.
4. Patients who have polypoid lesions of the colon are usually well nourished.

#### Proctosigmoidoscopy.

1. In 6 of the 11 cases, polypoid lesions also were present in the rectum.

#### Roentgenologic Examination.

1. The large intestine of the child is of proportionally greater length and caliber than is that of an adult. Castor oil seems the best agent to use in children for the purpose of preparing the large intestine for roentgenologic examination as it does not exaggerate this disproportion in length and caliber. Fifteen cubic centimeters is given to infants and 30 cc. to older children the night before the examination. A simple enema is given the morning of the examination.
2. The opaque enema is given as rapidly as possible as the child is apt to become unruly if the examination is prolonged. Sedation (with barbiturates) is sometimes necessary. A double contrast enema is always obtained.

#### Treatment.

The treatment of polypoid lesions of the colon



consists of transcolonic excision of the lesions or resection of the involved segment of the colon.

#### *Pathologic Changes.*

In 9 of the 11 cases, microscopic examination disclosed that the lesion was an adenocarcinoma, Grade 1 or low Grade 1. In the 2 remaining cases, the lesion was classified as an adenoma. Although polypoid lesions may be lipomatous, fibromatous, or angiomatous, the authors have never observed such lesions in the colon of children.—*Mary Frances Vastine.*

GERWIG, W. H., JR., and STONE, HARVEY B.  
Enteric intussusception in adults. *Surg., Gynec. & Obst.*, Jan., 1943, 76, 95-99.

Acute enteric intussusception in the adult is an entity that is encountered only occasionally. Polyps in the colon are quite common and their occurrence in the small intestine is rather rare, but a combination of polyps in both the large and small bowel is most unusual. A case is reported of an acute jejunal intussusception occurring in an adult in whom multiple polyps of both the large and small intestine were later found. Four weeks following the operation for intussusception a barium enema examination was done. The polyps in the large bowel were seen only when the double contrast study was made following evacuation of the barium.

In this paper, intussusception is thoroughly discussed as to:

1. Definition, classification, mechanism and etiology.
  - a. The primary or acute type occurs chiefly in infants at the ileocecal region. An underlying lesion is seldom found in these cases and once reduced it seldom recurs.
  - b. The secondary or chronic recurring type usually occurs in adults or older children and an organic causative factor is frequently present. In the large bowel, the chief offender is the malignant tumor while in the small intestine benign neoplasms (especially the adenomatous polyps and lipomas) are most often encountered as etiological factors. Any tumor of the intestines is a potential cause of intussusception and unless there is a definite contraindication it should be removed.

This is especially true if the growth is an adenomatous polyp for these polyps tend to undergo malignant change. Lawrence has reported 232 autopsy findings of polyps of the gastrointestinal tract with malignant transformation in from 6 to 7 per cent. It is in the descending colon, sigmoid and rectum that polyps bear the closest relationship to malignancy.

#### 2. Symptomatology.

- a. Primary type—young healthy infant suddenly begins to have colic-like pain, passes blood from rectum, develops an abdominal mass and shows signs of intestinal obstruction.
- b. Secondary type—occurs in an adult who may present varied symptoms and in whom a preoperative diagnosis of intestinal obstruction is usually made. The picture is that of high obstruction if in the small bowel and of slower low obstruction if in the large bowel. Bleeding from the rectum is seldom encountered. There is usually a history of irregular attacks of colic-like pain.

#### 3. Treatment.

Surgery—reduction in the primary form; reduction or resection in the secondary form.—*Mary Frances Vastine.*

MAYORAL, A. Motor changes observed fluoroscopically in the colon of a patient afflicted with a tumor in the hypothalamic region. *Am. J. Digest. Dis.*, Aug., 1943, 10, 305-307.

The author describes his observations in a case of a brain tumor (astroblastoma) of the right gyrus hippocampus with massive hemorrhage. The roentgenological examination of the upper gastrointestinal tract failed to show any pathologic condition; however, no barium was seen in the colon at the six hour examination. The findings of the author during the barium enema were the following: "During fluoroscopic observation, great difficulty was encountered in filling the descending colon, the progress of the opaque media was very slow due to marked spasticity. When the head of the column reached the mid-transverse colon propulsive motility became very active, barium was squeezed out of the lumen toward the anus. After 20 to 40 seconds the colon would calm sufficiently to allow further progress of the enema. Each advance, however, was met with further

and similar propulsive movements of the gut. The contractions were very forcible and complete. No barium remained in the portion of the intestine showing contraction except for a few flecks attached to the mucosa. In about 30 seconds these explosive movements would subside sufficiently to allow some barium to advance in the intestines. . . . the proximal portion of the colon was finally filled, but at no time during the period of examination, that lasted about five or six minutes, did the colon show complete relaxation. The movements of the colon were like those seen in cecal tuberculosis."

Two weeks later another barium enema examination was made. At this time no abnormality was found except for a localized area of what appeared to be thickened mucosa at the cecum.

Repeated stool examinations were negative for occult blood and amoeba. There were no signs of tuberculosis. At autopsy the gastrointestinal tract was found to be normal.—*Franz J. Lust.*

GOLOB, MEYER. The merits of sigmoidoscopy preceding a barium enema. *Am. J. Digest. Dis.*, May, 1943, 10, 182-184.

Golob describes a case of an adenocarcinoma of the rectosigmoid. Sigmoidoscopy was able to detect the tumor, whereas the roentgenological examination was not able to visualize the lesion. Canalization was noted while the barium enema was administered. The post evacuation roentgenogram might have given a hint that there was a tumor present. Golob emphasizes the importance of the direct examination in conjunction with all roentgenological examinations of the colon.—*Franz J. Lust.*

PROBSTEIN, J. G. and SENTURIA, H. R. Volvulus of the sigmoid colon. *Surg., Gynec. & Obst.*, Dec., 1943, 77, 669-672.

The occurrence of volvulus in this country is relatively infrequent. By contrast, sigmoid volvulus occurring as an acute abdominal emergency is very common in Russia and Germany. The frequency of redundant colons is attributed by most authors to a coarse vegetable diet rich in undigestible cellulose which makes a great demand on the pelvic colon as a fecal storehouse.

Two cases of volvulus of the sigmoid colon are reported. In 1 of the cases, hepatodiaphragmatic interposition of the colon was present in

addition to a volvulus of the megasigmoid, two relatively uncommon and usually distinct conditions.

The roentgenologic findings in hepatodiaphragmatic interposition of the colon (or hepatoptosis) were first described by Béchère in 1899 who wrongly interpreted the findings as those of a subphrenic abscess.

In their discussion of the cases presented the authors bring out the following points:

1. Volvulus may occur in the sigmoid-cecum and in the small intestine. The most common site is the sigmoid.
2. The symptoms of volvulus simulate closely the findings of other obstructive lesions of the colon or small intestine depending on the acuteness or chronicity.
3. Volvulus of the sigmoid shows a decided tendency to recur.
4. Untwisting the bowel in a case of volvulus accomplishes nothing toward removing the predisposing or etiological factors.
5. Since shortening of the mesentery, sigmoidopexy, and other procedures have not produced satisfactory results, it is the authors' opinion that an immediate obstructive resection should be attempted at the primary exploration if it is possible.—*Mary Frances Vastine.*

METHENY, DAVID, and NICHOLS, H. E. Volvulus of the sigmoid. *Surg., Gynec. & Obst.*, Feb., 1943, 76, 239-246.

Volvulus of the sigmoid occurs when the sigmoid is so redundant and the mesentery so relaxed as to permit a twisting of this part of the gut. The obstruction may be partial, complete, or strangulated. Clinically significant redundancy of the gut may be congenital or acquired. Too much sigmoid may be a congenital abnormality. The authors believe that redundancy may be increased over a period of years to the point where it will cause strangulated volvulus. The symptoms include:

1. Attacks of partial obstruction of the colon at first. Obstipation for a day is followed by a more or less distended abdomen and gas pains below the navel.
2. Tenderness on the left side.
3. Occasionally the redundant sigmoid may be palpated above the navel on the left side. It seems like a phantom cyst that disappears as it is being examined.
4. When a patient has learned that an enema,

especially one taken in the knee-chest position, will produce relief, recurrent volvulus of the sigmoid should be suspected.

Since one-third of all patients having barium enemas show some redundancy of the sigmoid, the roentgenologist is not justified in making the diagnosis before obstruction occurs. The incidence of recurrent volvulus of the sigmoid is more common than the diagnosis. It has been estimated that volvulus in this region accounts for 15 per cent of intestinal obstructions. In the King County Hospital, Seattle, Washington, from 1934 to 1941, 496 patients with intestinal obstruction were admitted. Of these cases 5 were due to volvulus of the sigmoid. The authors report these 5 cases in detail.—*Mary Frances Vastine*.

HEILBRUN, NORMAN. Roentgen evidence suggesting enterocolitis associated with prolonged cathartic abuse. *Radiology*, Nov., 1943, 41, 486-491.

A case is described in a white woman thirty-six years of age in which there were extensive changes in the lower part of the small bowel and throughout the large bowel. The roentgen findings were those of ileitis and colitis. The article is illustrated with roentgenograms showing the changes. The patient had none of the clinical signs of these diseases and the only factor that could be found which seemed to explain them was that for twenty years the woman had been stubbornly constipated and had taken irritant cathartics daily throughout that period. The roentgen findings improved markedly as soon as the use of these irritant drugs was stopped.—*Audrey G. Morgan*.

#### GYNECOLOGY AND OBSTETRICS

THOMAS, HERBERT. Roentgen pelvimetry; a commentary. *Surg., Gynec. & Obst.*, Aug., 1943, 77, 153-156.

Because of the definite clinical significance of variations in the bony pelvis, the experience of the writer has led him to recommend that all primigravid women should have the benefit of the roentgen survey of the pelvis. During the past seven years, 2,000 patients have been so surveyed in the author's clinic. The comments made include:

1. The two pelvic views used are the inlet and lateral ones. A 36 inch target-film distance is used so that distortion is minimized.

2. *The inlet view* is taken with the patient semirecumbent, using a back rest and centering the target 6 cm. posterior to the upper symphyseal border. The pelvic inlet is made parallel to the film by measuring vertically the distance from the table top to a point 1.5 cm. below the upper symphyseal border on its anterior surface and measuring vertically the distance from the table top to the interspace posteriorly between the fourth and fifth lumbar vertebrae. The patient's position must be such that these two points are equidistant from the table top, for they establish the level of the pelvic inlet.

*The lateral view* is taken with the patient standing in the lateral position, the target being centered at the upper edge of the acetabulum. The correction of distortion in both views is made with an isometric rule introduced in the plane to be measured. In the inlet view this is done by a double exposure and in the lateral view this scale is projected at the one exposure.

3. It has been found that an allowance for each patient of fifteen to twenty minutes is sufficient for the roentgen study. The inlet view is taken on an 8 by 10 inch film and the lateral on an 11 by 14 inch film.

4. Pelvic outlet views are not included in the roentgen survey as roentgen methods are not too satisfactory for accurate measurements in this portion of the pelvis and the usual palpatory methods are adequate for both mensuration and for determining the important contours.—*Mary Francis Vastine*.



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